MAY 11, 1961

DESIGN

A PENTON PUBLICATION - BIWEEKLY

DESIGN ENGINEERING SHOW GUIDE

Contents, Page 3

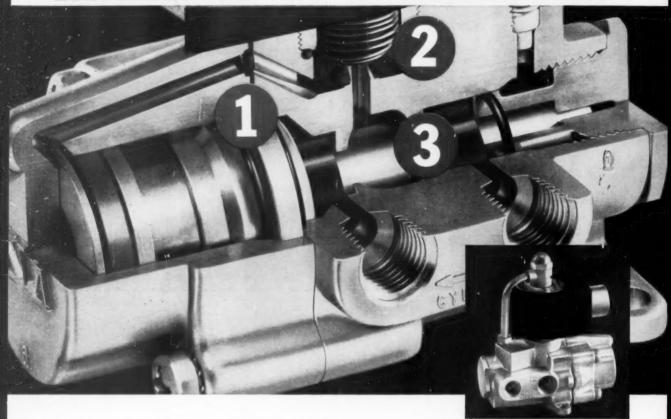


HE STEVENS RICE 313 N. FIRST ST. NUIVERSITY MICH.

FARHSWORTH

this is the way a valve is built to last

MILLIONS OF OPERATIONS:



NEW LOW-COST ASCO 4-WAY SOLENOID VALVES HAVE BEEN CYCLED MILLIONS OF OPERATIONS WITHOUT FAILURE

- TIGHT SEATING
 with unique patented
 poppet-type seats—
 Patent Nos. 2,624,585—
 2,775,982
- RELIABLE OPERATION
 ASSURED—failure to
 return due to residual
 magnetism is eliminated
- POWER OPERATION IN BOTH DIRECTIONS—
 main valve not dependent upon return springs

Installation is simplified; the 8344 may be mounted in any position! Poppet seals and a unique combination of metal-to-metal with resilient seating enable these and other ASCO 4-way solenoid valves to provide dead-tight shut-off, even on air, without lapping, grinding or close adjustments. The utter simplicity of design, eliminating return springs and power-operating the main valve in both directions, assures unprecedentedly reliable performance without maintenance for indefinite periods.

The new ASCO Bulletin 8344 valve is the latest embodiment of over half a century's design and development experience. Its low cost makes it economical even as a 3-way valve, with one pipe connection plugged.

Here are the pertinent statistics:

Pipe Size	Catalog No.	Solenoid Enclosures	List Prices†	Operating Information
1/4"	83440	Std.	\$48.00	Pressures: to
1/4"	83444	Expl. proof	56.00	250 psi.
3/8"	83441	Std.	48.00	Temp: to 212° F.
3/8"	83445	Expl. proof	56.00	Fluids: air, water hydraulic oil

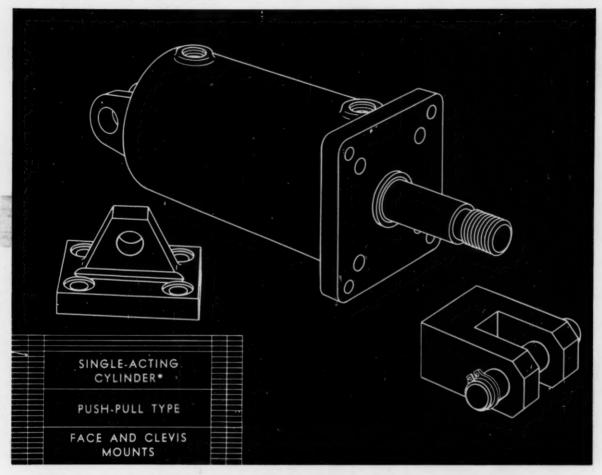
† Subject to trade and quantity discounts.

Other ASCO 4-way valves come in pipe sizes from ¼" to 1½" for pressures to 500 p.s.i. For complete information write for Catalog 202, and see the hundreds of types of 2, 3, and 4-way solenoid valves available for immediate delivery from the world's largest stock.

ASCO Valves ASCA



DEPENDABLE CONTROL BY Automatic Switch Co. 54 A HANOVER RD., FLORHAM PARK, N. J. - FRONTIER 7-4600 - AUTOMATIC TRANSFER SWITCHES - SOLENOID VALVES - ELECTROMAGNETIC CONTROL



New MEAD single-acting cylinder can PUSH or PULL



DESIGN ADVANTAGES

- Pressure tightening seals throughout.
- 3-way instead of more costly 4-way valve may be used.
- Conical return spring assures long life and uniform tension.
- Return spring recessed in cover for compactness.
- Oilite rod cartridge provides durable wearing surface.
- Air consumption considerably less than that on double-acting models.
- Full floating double-lip piston cup for extended life.

Wherever a job calls for pushing, squeezing, lifting, holding, tilting or sliding, there's a place for MEAD Air

*May be used as a double-acting cylinder if

With the latest addition to its famous "Air Clamp" line, MEAD presents two new mounting styles that combine spring-return simplicity with push-pull versatility. Using only slightly more than half the air volume required by double-acting cylinders of the same size, MEAD Air Clamps also reduce the complexity of valving and piping. Two new mounting styles — face and clevis — offer complete application flexibility. The new MEAD push-pull cylinders are available in $2\frac{1}{4}$ ", 3", 4" and 5" bore sizes with 1", 2" or 3" strokes.

For further details and information on fast delivery and economical prices, write MEAD today.



ASK YOUR MEAD MAN for more dollar-saving automation ideas



The KAPSEAL® is a Teflon® "boot" which is used with a standard O-ring to provide a good seal with superior frictional and wear characteristics.

LONG LIFE The KAPSEAL has been tested on dynamic installations in both the laboratory and the field with outstanding results. Tests have run over 4,000,000 cycles before they were discontinued, while a hydraulic control valve has logged over 2,000,000 cycles. On a rod-seal installation it is performing satisfactorily at 1500 PSI.

LOW FRICTION The Kapseal is made out of Teflon because of the extremely low coefficient of friction this material has. It provides a sealing member with low breakout friction. Teflon is superior to rubber in this respect because its breakout and running friction are the same while rubber's breakout friction is about 50 times greater than its running friction. Thus the Kapseal-O-ring combination provide good sealing characteristics, and the ability to perform satisfactorily after prolonged periods of inactivity.

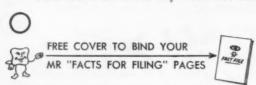
COMBINES WITH A STANDARD O-RING

The Kapseal comes in two styles, Kin and Kex. Kin is used when the ID of the seal is the sealing surface, while Kex is used when the OD is the sealing surface. The Kapseal combines with a standard O-ring and the combination can be installed in any gland that was designed for the O-ring only. The combination can also be used to replace stacks of V-rings giving a greatly simplified design. A "buttoned-up" design is possible because the long-life, low-friction characteristics of the Kapseal reduce seal replacement requirements to the extent that the mechanism can be sealed shut.

WHERE LIFE OR FRICTION IS A PROBLEM. THE KAPSEAL IS THE ANSWER

KAPSEAL is a trademark of Minnesota Rubber Co.
Teflon is a trademark of the DuPont Company

FOR MORE INFORMATION ON THE KAPSEAL . . .



WRITE



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Front Caver: A colorful representation of the mechanical, electrical, and hydraulic fields is George Fornsworth's way of spatlighting this year's Design Engineering Show. An engineer's-eye view of the projected goings-on starts on Page 211.

SHOW

Elastic Suspensions Protect Missile Guidance Systems 26
R. P. THORN—News Report—Solutions to sophisticated vibration-control problems in missile inertial-guidance systems suggest possibilities for more prosaic applications.
Using Outside R & D 162
ROBERT G. MURDICK—A close look at the advantages and disadvantages of hiring an outside agency to do research and development work.
Laminated-Plastic and Vulcanized-Fiber Parts 171
F. J. HUTTA—Principles of sound specification practice, and particular design details to help in getting maximum benefits from laminated plastic and vulcanized fiber.
Push-Pull Controls
MELVIN E. LONG—A comprehensive look at a simple, effective motion-transmitting device: Available types, selection factors, and design practices.
Preventing Fatigue Failures 191
F. B. STULEN, H. N. CUMMINGS, and W. C. SCHULTE—Part 2: Geometric Stress Concentrations—How to prevent fatigue failure due to mechanical flaws in the material.
Fractional-Horsepower Motors 196
JOHN CAMPBELL—Part 1: Electrical Considerations—A guide to specifying flap motors from the standpoint of type, performance, power, and application.
Hydraulic-System Temperatures 205
CHARLES D. WOOD—Data Sheet—A simplified procedure that avoids trial-and-error calculations in predicting maximum hydraulic-system temperatures.
Design Engineering Show Guide 211
A preview of events and exhibits at the 1961 conference and show in Detroit: The latest in parts, materials, and engineering-department equipment; outline of conference program; list of exhibitors; floor plan of exhibit area.
Strength of Refractory Metals
AL DONLEVY and JACK K. Y. HUM—Design Abstracts—A quick look at the strength of



shock-damping calculations . . . molecular seals . . . fhp motors.



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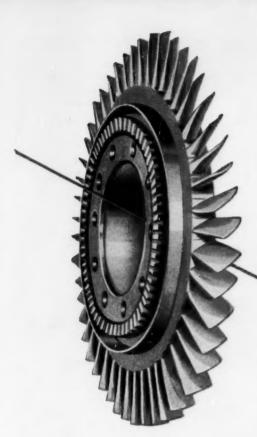


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MIDVAC INCREASES STRESS RUPTURE LIFE 6 TIMES FOR JET TURBINE PARTS



MIDVAC STEELS ARE PRODUCED BY THE MIDVAC PROCESS OF CONSUMABLE ELECTRODE MELTING

When maximum reliability in the high temperature range and minimum rejects are required that's the place to specify Midvac Steels. These steels assure super alloys of increased tensile, higher impact properties, improved stress rupture strength at elevated temperatures and longer fatigue life.

As an example air melted No. 901 had excellent high temperature strength, but often failed slightly below the required stress rupture hours (15) with little to spare over the minimum ductility requirements. We'll over 100 hours can be attained with Midvac melted No. 901.

The Midvac Process of consumable electrode melting eliminates atmospheric contamination, ingot soundness is improved, segregation is reduced, workability is increased and product quality is stepped-up. Midvac Steels are offered in many alloys as billets or forgings to meet the most critical design specifications of jet engine parts, missile and aircraft components and other products requiring properties beyond the capabilities of conventional steels. Let M-H metallurgists help you select the right alloy to meet your product's specifications. Write...

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VACUUM AND CONSUMABLE ELECTRODE STEELS . BACK-UP ROLL SLEEVES . FORGED STEEL ROLLS . FORGINGS RINGS . PRESSURE VESSELS . INDUSTRIAL KNIVES . DIE BLOCKS . MATERIALS HANDLING EQUIPMENT

DESIGN

ENGINEERING NEWS

Sophisticated Simulator Checks Out Chopper Pilots

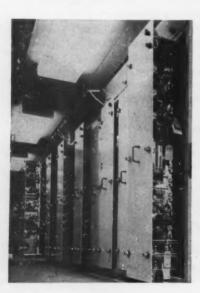
FALLS CHURCH, VA.—Pilots who train in a new flight simulator will be able to handle the HSS-2 submarine-hunter/killer helicopter the first time they take it up. This was proved by Franklin E. Papin, Melpar Inc. design engineer, who practiced on the simulator, then checked out in the new aircraft on his first try, although he had never flown a helicopter before.

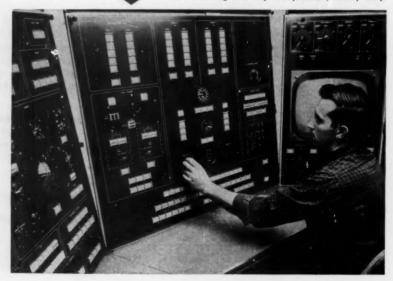
Developed by Melpar for the Navy, the flight trainer is the first to be delivered before the "companion" aircraft is operational. Housed in two trailer vans, it simulates the behavior of twenty HSS-2 systems, including oil and fuel, hydraulic, blade-folding, landing gear, and armament. In addition, it teaches the pilot trainees how to react to malfunctions and bad weather, and it can be used to train both pilots and crewmen in sonar tactics and use of the radio-navigation equipment mounted in the aircraft.

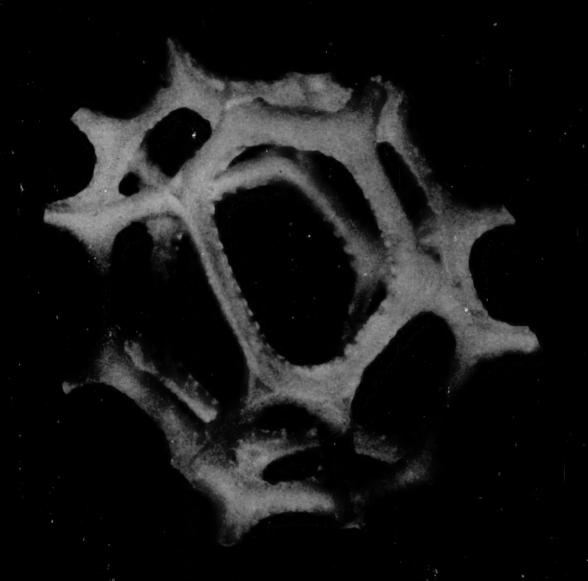
Comparisons between trainer and actual flight data show that in all important respects, the helicopter and simulator performances are almost indistinguishable. Even flight sounds, control-stick pressures, and structural vibrations have been built into the trainer.



Student in the simulator cockpit (above) feels realistic pressures when he operates his control sticks and pedals. Cloud formations, lightning flashes, and other ersatz weather conditions can be projected on the windshield in front of him. The instructor, seated at a control console (below, right), can vary "outside" temperature and pressure, wind force, air roughness, cause the trainer to malfunction, etc. Problems imposed by the instructor are digested by computers (below, left).







This versatile product may have a place in your design. Scott Industrial Foam, a unique "open pore" urethane, comes in a wide variety of pore sizes, and cuts readily to any shape. Easy to clean, strong, resilient. Has 97% void volume. Already in wide use for demisting, liquid detraining, coalescing, cosmetics. It revolutionized the air filtration industry. Can it revolutionize yours? See it, feel it at Scott Booth 1112, Design Engineering Show. If you can't be there, write Dept. A, Foam Division, Scott Paper Co., Chester, Pennsylvania, for kit conscient product of research by scott Paper Company

Aluminum Enters Low-Hp Race

High-power-to-weight ratios, interchangeable parts are featured in two new general-purpose engines...

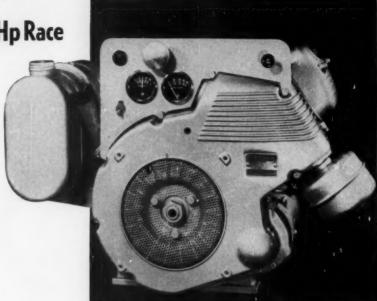
Waukegan, Ill.—At a time when automotive manufacturers are relying on aluminum engines to reduce vehicle weight, the great majority of small general-purpose engines are still made largely of cast iron and steel. The tradition has finally been fractured, however, by a well-known manufacturer of aluminum outboards.

Two die-cast aluminum engines developed by Outboard Marine Corp., Waukegan, Ill., claim an impressive advantage in small-engine power-to-weight ratio. Rated at 9 and 18 hp, the four-cycle, air-cooled powerplants weigh in at 7 to 9 lb per horsepower, vs. 10 to 12 lb per horsepower for comparable cast-iron engines. They also incorporate a number of other important features, some unique in small-engine design:

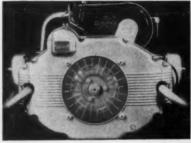
• Emphasis on standardization has resulted in a high degree of parts interchangeability. Of a total 238 parts in the 18-hp model, 150 fit the 9-hp engine.

• Two-piece engine block is easily assembled and disassembled (two tapered dowl pins insure alignment). Mating surfaces of the two halves are precision milled; no gaskets are needed. Seal is a liquid mastic, brush applied.

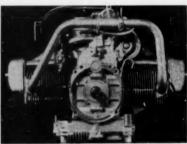
 Pressure lubricating system, using a positive-displacement gear pump, supplies oil at 40 psi. The system includes an oil strainer, filter, bypass valve, and pressure switch (for red light on the control panel).



One-cylinder version of OMC's die-cast aluminum engine delivers 9 hp at 4000 rpm; 15 lb-ft of torque at 2500 rpm. It weighs 78 lb. Model shown above is equipped with optional side-mounting gas tank and instrument panel. Wide selection of options and modifications are available, including four different types of engine bearings, standard or Stellite valves and seats, valve rotators, five different starting mechanisms, a variety of instrumentation, and a glass-fiber engine shroud. Engines can be converted to LP, kerosene, or natural gas.



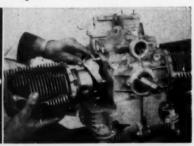
Two-cylinder version of the engine delivers 18 hp at 4000 rpm; 32 lb-ft of torque at 2500 rpm. It weighs 126 lb with air cleaner and fuel tank. Displacement—43.3 cu in.—is twice that of the one-cylinder engine; bore and stroke are the same: 3.5 x 2.25 in. Crankcase oil capacity is 3 qt.



Both engines incorporate design features which are unusual for powerplants of their size: Overhead-valves (below, left) contribute to cooler running; two-piece block (center) easeengine maintenance; single die-cast cylinders (right) eliminate separate heads, head bolts, and gaskets.





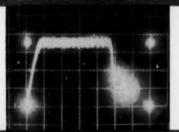


MOM HIGH PERFORMANCE LIQUID DASHPOTS

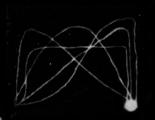
Oscilloscope photos show curve capabilities of Taylor Liquid Dashpots assembled from standard components



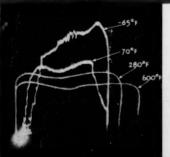
VELOCITY CONSCIOUS TYPE V Minimum impact or shock for any input velocity (used on aircraft carrier application)



PRESSURE RESPONSIVE TYPE R
Maximum force and minimum stroke at all
velocities. Note absolute flat topped curve
at maximum force (used on manned aircraft)



TAYLOPED METERING PIN TYPE T Provides any shape energy profile (used on electric circuit breaker)



ENVIRONMENTAL CAPABILITIES
Made possible by stability of Taylor liquids'
and seals (used on missile systems)

22 Standard Models SINGLE OR DOUBLE ACTING

TAYLORED to YOUR SPECS

NOW for the first time standard precision Dashpots at competitive prices are available to meet your exact energy absorption requirements. Standard off-the-shelf components developed from Taylor Liquid Spring Shoks provide wide variations in capabilities at low cost to meet desired shock curves. Complete line includes wide range energy absorption to fit specific envelope areas and SAVE WEIGHT, SPACE AND COSTS. It pays, in multiple savings, to standardize on Taylor Liquid Dashpots.

ALSO LOW COST TAYLOR PLASTIC DASHPOTS

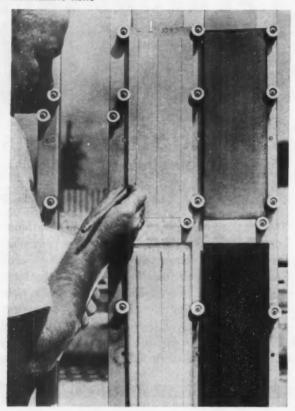


Patented Taylor Plastic Dashpot construction utilizes the unique high density structure to hold peak shock loads with moderate strength plastics. These Dashpots are ideal for applications requiring large production quantities at lowest unit costs and provide a large range of energy absorption.



TAYLOR DEVICES, Inc.

206 MICHIGAN AVENUE, NORTH TONAWANDA, N. Y.
(On Tenewande Island in the Niegers River)



After three years exposure to the atmosphere, the Zincgrip A, Paintgrip panel (upper left) shows no evidence of rust, even in scribe marks that break the painted surface. The unpainted panel (upper right) also held up well. Painted sample of cold-rolled steel, tested for comparison, corroded along the scribe marks (lower left), and the unpainted specimen rusted badly all over (lower right).

New Look in Galvanized Steel

Spangle-Free Surface Holds Onto Its Paint

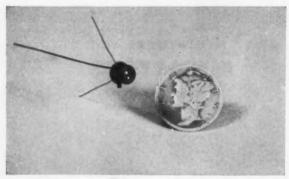
Middle Town, Ohio—Paint adheres to its surface so well that a new galvanized steel may oust other materials from many corrosion-resistant applications. It can be drawn, formed, and lock-seamed to the limit of the base metal without the paint flaking or peeling. Rated at a 1.25-oz zinc-coating (under ASTM A-93), the galvanized steel tends not to rust in moist atmospheres, even when it's unpainted.

Developed by Armco Steel Corp., the hot-dipped steel is produced entirely free of spangles, thereby eliminating spangle "show through." In addition, the surface is chemically treated to improve paintability in terms of smoothness, adherence, and service life.

Designated Zincgrip A, Paintgrip, the new sheet also has spot-welding characteristics that are superior to other paintable galvanized steels. According to T. F. Olt, Armco vice president, "the number of resistance spot welds that can be made before tips need redressing is more than double that possible on regular galvanized sheets."

Zincgrip A, Paintgrip is expected to challenge all other paintable zinc-coated sheets; it can utilize lighter coatings of zinc. It is also expected to compete with cold-rolled steel treated for painting, and with aluminum. Applications for the new material should develop in the automotive, appliance, heating and air conditioning, and farm-equipment fields, as well as in architecture and construction.

High-Output Photocell Actuates Load Directly



A bistable switch having many properties similar to those of a gas thyratron, the Photran is a PNPN device that is triggered by light energy. It has a high impedance (over 10 meg ohms) in the off state, a low impedance (under 10 ohms) when on. Once triggered, the photocell stays conducting until electrically turned off—light energy need only be applied momentarily. And because light intensity needed to trigger the Photran depends on bias current, the device can be used as an electro-optical gate. This control property allows simplification of many complex switching circuits.

SALEM, MASS.—A new type of photocell, called Photran, differs from photoconductive and photovoltaic devices in that once triggered, its output is independent of light intensity. Developed by Solid State Products Inc., the tiny semiconductor device promises to greatly simplify optical control circuits.

Basically a silicon-controlled PNPN switch, the new photocell can deliver up to 300 ma of load current—many times that handled by other types. Because of this high output (determined primarily by the load), the device will directly actuate many loads without the help of intermediate relays, amplifiers, and similar elements. And since response time can be below 1 mu sec, the photodevice should find applications in high-speed counting, sorting, power control, and limit switching.

Load power delivered by Photran can be as high as 40 w continuous (200 v, 200 ma) at an efficiency of 99 per cent. Voltage drop in the on condition is below 1.5 v at all current levels under 200 ma, and power-dissipation ratings are 0.25 w at 25 C ambient and 0.5 w at 75 C case temperature.



NOPAK

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DESIGN BARRIER

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to its CVA* Products

CLASS 7 CYLINDERS

Made with pressure cast and extruded aluminum. Square head and barrel eliminate the need for tie-rods. Mounting holes can be drilled or tapped directly into cylinder tubing. Cylinders in 3/4, 1/1, 1/2, and 2" bores are pressure rated for 200 psi air or 1000 psi oil in the most popular stroke lengths. Available in 7 universal mountings.

Write for Catalog 107.

MODEL "V" SOLENOID



until opposite sole-noid or pilot is actuated

Catalog V

ROTATING DISC VALVES

The original NO-PAK Valves, available in 2-, 3-, 4- way, and many special cycles for control of cylinders to 500 psi air or hydraulic. Precision lapped rotating disc and body seat are always protected from pressure flow or exhaust.

exhaust.

Write for Catalog 102A.

CLASS 3 & 6 CYLINDERS

Class 3: a compact, steel plate, square-head cylin-der with tie-rod and honed steel tubing construction.
Working pressures to
3000 psi. Class 6: similar
in construction to Class 3, but for air pressures to 250 psi; hydraulic to 1500 psi. Square head design permits interchangeable mounting dimensions. Meet or exceed JIC requirements. Available in 18 standard mountings.

Write for Catalog 103 or 106.

CLASS M CYLINDER *

ACTUAL

SIZE

1" BORE

BY 3"

1000 PSI

STROKE #

Honed steel tubing, welded flange construction eliminates tie-rods. For all types of heavy duty air or hydraulic applications at pressures up to 650 psi. A vail a ble in 6 standard mountings. standard mountings. Write for Catalog 101A.

> CYLINDERS **VALVES** A \ ACCESSORIES

NOPAK offers a complete line of Matched Fluid Power Components.

CLASS 1 & 2 CYLINDERS

NOPAK-MATIC VALVES

Fast acting, high vol-Fast acting, high volume air valves in pipe sizes from ¼" to 1¼" with master (air piloted) single or double solenoid. Removing cover plates affords easy access to piston poppets housed within removable, interchangeable cartridges. 100% J.I.C. Easily modified for vacuum operation.

Write for Catalog 105.



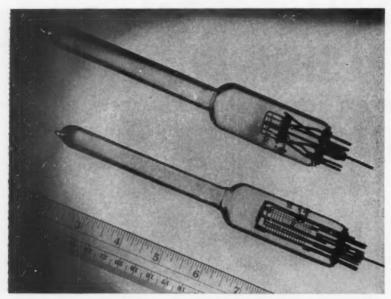
GALLAND-HENNING NOPAK DIVISION

2752 31st Street MILWAUKEE 46, WIS.

Circle 209 on Page 19

Paired Gages Measure Wide Pressure Range

Co-operate To Cover 10⁻¹⁰ to 10⁻¹ mm Span



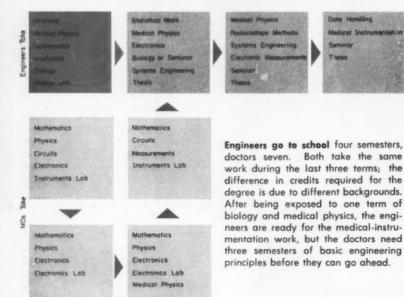
Externally identical, both gages are packaged in cylindrical glass envelopes, 1-in. diam \times 2 $\frac{3}{4}$ in. long, and fitted with standard 8-pin tube bases. Air cooling provides adequate heat dissipation. The "high-pressure" gage (upper tube) has a thoria-coated iridium filament which permits measurements in high-oxygen atmospheres. In the low-pressure gage, three separate tungsten filaments can be connected in any series-parallel combination.

PITTSBURGH—Two ionization gages, developed by Westinghouse Electric Corp., team up to pinpoint low gas pressures over an extremely wide range. One of the vacuum devices measures the "high" pressure end of the range, from 1 x 10⁻⁵ to 5 x 10⁻¹ mm of mercury; the other reads pressures from 1 x 10⁻¹⁰ to 1 x 10⁻³ mm.

The new gages are the first designed for enough overlap to "cooperate" with each other. The two are three-electrode devices; each employs a heated cathode, positively charged electron collector, and negatively charged ion collector.

In use, the three elements are surrounded by the gas under study. Bombarded by electrons streaming from cathode to electron collector, molecules of the gas are positively ionized and attracted to the negative-ion collector. Current produced is compared to grid current, and the ratio is directly proportional to the pressure of the closed system. When amplified, the ratio-signal can drive indicating, switching, and recording devices.

Engineers Offered M.S. in Medical Instrumentation



PHILADELPHIA—To provide the medical profession with some much needed engineering help, Drexel Institute of Technology is now offering a full-time graduate program in medical instrumentation. Designed for both the engineer (or natural scientist) who knows little about biology, and the medical doctor with no technological training, the program leads to a Master of Science degree.

As preliminary work, the engineers study biological principles and the doctors take mathematics, physics, and electronics. Then the two groups merge for combined study of measurement, analysis, and control as applied to bio-medical systems. Students work in small teams made up of men with different backgrounds. In addition to classroom work, group research on physiological problems will be conducted at the nearby Presbyterian Hospital.



Choosing exactly the right bearing can mean a vital difference in performance, cost and product life. That's why it pays to call Torrington first.

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The Redstone Saga:

U. S. Gambit in Manned Spaceflight

A DIRECT decendant of Germany's V-2, the Redstone missile is no stranger to important jobs. When the unfortunate Vanguard program began faltering late in 1957, the Army's distinguished missile team at Redstone Arsenal, headed by Dr. Wernher von Braun, was finally commissioned to put the U.S. in the space race. Obvious choice of a booster was the dependable Redstone missile. Beefed up and modified somewhat, it emerged as the so-called Jupiter-C, and within 90 days of the date Washington signaled for help, the U.S. had a satellite in orbit.

At a time when U. S. prestige is lagging somewhat, due partially to Russia's scientific achievements, success of the Mercury program is critical. Yet there are even dissenters in this country who belittle the importance of the program. In answer to this, the value of the Mercury project was effectively described, at its inception, by Dr. High L. Dryden, deputy administrator of NASA: "The situation is a little bit like determining the value of the airplane at the time of the Wright brothers. We have the utmost confidence, based on the past . . . that man is going to be in space, find useful things to do in space, and

Standing 83 ft high, the Mercury-Redstone combination has a lift-off weight of 66,000 lb. Redstone engine burns alcohol and lox to develop a thrust level of 78,000 lb. Instruments installed in the booster will telemeter 65 measurements concerning its behavior during flight. This is in addition to telemetry from the capsule. According to flight plan, Redstone will carry the capsule to an altitude of 125 miles, and a distance of 200 miles. flight will last 161/2 minutes. Capsule will be accelerated to a speed of 4000 mph and will withstand forces as high as 61/2 g during exit and 11 g during re-entry. Weightless time of 51/2 minutes will be sustained.

Covered with corrugated shingles of nickel-cobalt alloy—to allow for expansion from the heat of re-entry—the Mercury capsule represents an incredible accomplishment in miniaturization. Measuring 9 ft high by 6 ft in diameter it offers less room, empty, than a telephone booth, yet carries as much instrumentation as an average airplane. Most systems in the capsule are in duplicate or triplicate.

that we must begin to study the accompanying problems. This project will advance the general technology of space at a faster rate than almost anything else that I can think of.

"If you do not have such an integrating project, you get engaged in a lot of research in various directions, but not concentrated on accomplishing a mission.

"A secondary result of all of this work, already reflected rather widely throughout our industrial structure, is the development of materials, devices, and fabricating methods which have come because the Mercury Project is at the forefront of our technology."



14

Solid-Fuel Super Boosters Called 30 Months Away

SACRAMENTO, CALIF.—A mammoth solid-fuel booster that would develop 17 million lb of thrust could be operational within 30 months. And the rocket, capable of pushing a 7 million lb vehicle into space, could be designed by current methods and techniques, Aerojet-General Corp. recently reported to NASA. The booster would be the first stage on a four-stage vehicle. All three upper stages would have liquid oxygen/liquid hydrogen engines.

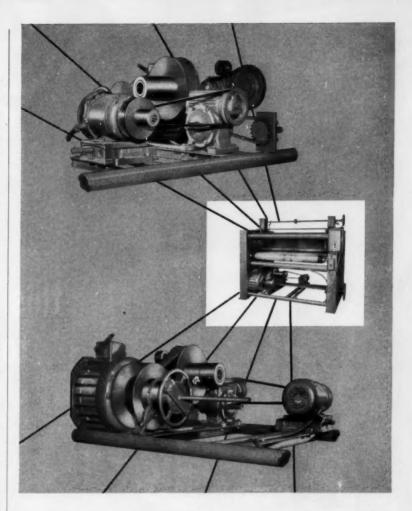
Consisting of seven 140-in. diam solid-fuel engines clustered together, the proposed vehicle could place a payload of more than 350,000 lb in orbit, or it could accelerate 170,000 lb to escape velocity. Although the solid-booster system is the largest ever conceived, production cost per pound would be less than that of the low-cost Scout booster.

A smaller booster capable of 2 million lb thrust can be ready within 24 months. Weighing about 500 tons, it would consist of four clustered 100-in. diam engines. A second booster of about the same weight could also be designed, using a single 140-in. diam engine. It would develop 2.4 million lb of thrust. Either of these engines could accelerate a 16,700-lb payload to escape velocity, or put 45,000 lb into orbit.

Tips for Rocket Designers

As part of a feasibility study on super-boosters, Aerojet-General engineers investigated rockets up to 24 ft in diameter. They found the most versatile and efficient unit to be the 140-in. diam engine with an individual-segment weight of 110,000 lb. They also found that the segment concept, in which individual slabs of fuel are added to an engine as thrust requirements increase, is most feasible for the large boosters.

A single stationary nozzle equipped with a liquid injection thrust vector control was also recommended. The nozzle was chosen because it requires the least development, although the company reported that a single gimbaled nozzle similar to that used in the Minuteman, would also be satisfactory.



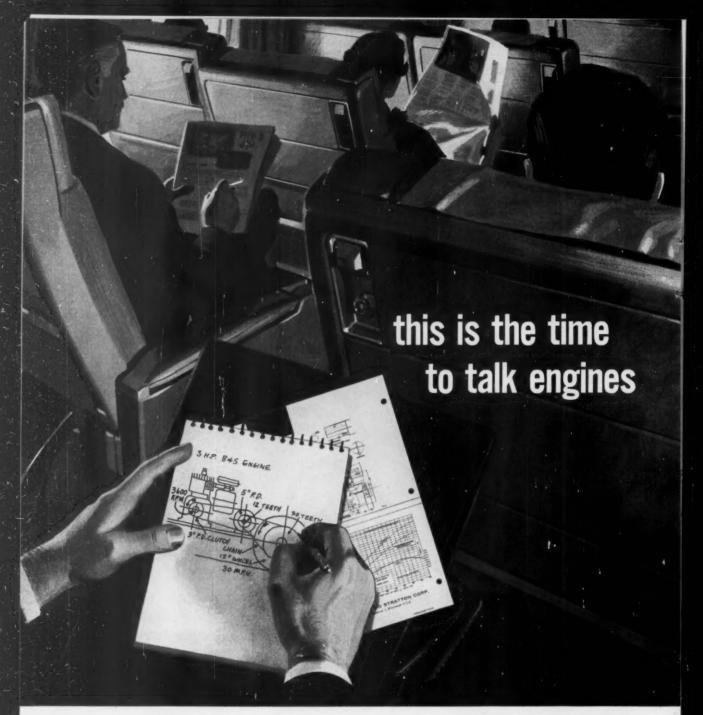
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HELPFUL LITERATURE

Descriptions of items start on Page 268. Starred items are from April 27 issue.

Electrical, **Electronic**

- 607 Precision Switches. 20 pp. Micro Switch Div., Minneapolis-Honeywell Regulator Co. 613 Temperature Centrols. 8 pp. Fenwal Inc. 616 Traction Motors. 4 pp. General Electric Co. 620 Electrical Equipment. 8 pp. Helipot Div., Beckmon Instruments Inc. 621 Instrument Meters. 4 pp. Holtzer-Cabot Motor Div., National Pneumotic Co. Inc. 627 Zener Diedes. 4 pp. CBS Electronics. 637 Wire-Wound Resistors. 6 pp. Ortho Precision Resistors Inc. 638 AC Motors. 16 pp. Reliance Electric & Engineering Co.
- neering Co.

 639 Power Supplies. 24 pp. Dressen-Barnes Elec-tronics Corp.

 640 Shunt-Grade Wire. 4 pp. Molecu Wire Corp.

 642 Heat Radiators. 16 pp. Industrial Div., Birtcher

- 42 Neat Radiators. 16 pp. Industrial Div., Birtcher Corp.

 759 Adjustable-Speed Drives.* Motodrives for V4-40 hp. Catalog G-100, 88 pp. Reliance Electric & Engineering Co.

 760 Stock Transformers.* Almost 900 units for industrial uses. Catalog C5-101, 34 pp. Chicago Standard Transformer Corp.

 761 Metalized Myler Capaciters.* Data on miniature, hermetically sealed units. Potter Co.

 762 Worm-Gear Metors.* Right-angle, single and double-reduction types. Bulletin F-1971, 6 pp.

 U. S. Electrical Motors Inc.

 763 Piezoelectric Bevies.* Applications, performance characteristics of various substances. 16 pp. Clevite Electronic Components.

 764 Miniature Electric Eyes.* For automation applications. Bulletin 611, 22 pp. Photomation, Inc.

- inc.

 765 Servo Motors.* Two-phase, four-pole, reversible induction units. Bulletin M0-3.7A, 14 pp. Holtzer-Cabot Motor Div., National Pneumatic Co. Inc.

 766 Color-Measurement automatic technique. Two booklets, 4 pp. each. Colorimetry Div., Allied Research Associates

- Colorimetry Div., Allied Research Associates Inc.

 767 Precision Potentiometers.* Defails on 1544 Squaretrim standard units. 6 pp. Potentiometer Div., Daystrom Inc.

 768 Teflon Terminols.* Press-Fit line described. 4 pp. Sealectro Corp.

 799 In-Line Readeuts.* Comparison of major types. Foct-Finder, 16 pp. Electronic Tube Div., Burroughs Corp.

 770 Transistorized Power Supplies.* Specifications for 53 standard units. Catalog 401, 4 pp. Invar Electronics Corp.

 771 Terminal Insulators.* Complete data for 62 standard insulators. Bulletin 161, 24 pp. Coors Porcelain Co.

Hydraulic, Pneumatic

612 Adapter Fittings. 16 pp. Parker Fittings &

- Hose Div., Parker-Hannifin Corp.
 614 Hydraulic Pumps. 12 pp. Kobe Inc.
 625 Air Cylinders. 20 pp. Sheffer Corp.
 632 Ball Velves. 32 pp. Hills-McCanna Co.
 633 Nozzies, Accesseries. 8 pp. Spraying Systems
- Co.

 635 Centrel Valves. 8 pp. Ledeen Inc.
 614 Power-Cylinder Accessories. 2 pp. Hannifin Co.
 772 Valve Selector Chart.* Selection of solenoid
 valves for specific uses. Bulletin SL-1, 4 pp.
 J. D. Gould Co.
- J. D. Gould Co.

 773 Pilet-Operated Valve.* Describes Tube-0-Matle unit. Bulletin 91043, 4 pp. Airmatic Valve Inc.

 774 Venturi Valves.* For aircraft, nuclear, industrial, marine uses. 6 pp. Fox Valve Development Co. Inc.

 775 Shaft Seels.* For reciprocating and low-speed rotary shafts. 6 pp. Del Mfg. Co., Div., Arrowhead & Puritas Waters Inc.

 776 Liquid Spring Shocks.* Compressible spring Shoks described. Handbook CH-1, 12 pp. Taylor Devices Inc.

Mechanical Equipment

- 601 Universal Joints. 8 pp. Lovejoy Flexible Cou-
- 615 Spiral Bevel Gears. 6 pp. Perkins Machine &

- Geor Co.
 617 Ring Sprockets. 8 pp. Cogmatic Div., American-Marietta Co.
 624 Bell Dute. 20 pp. SKF Industries Inc.
 628 Flexible Meter Ceuplings. 6 pp. Link-Belt Co.
 777 Ball Bearings.* Data on RBM miniature unifs.
 Catalog 4E, 4 pp. Londis & Gyr Inc.
 778 Chain Selection Chart.* Choosing pitch size for power-transmission chain. Foote Bros. Geor &
- power-transmission chain. Foote Bros. Gear & Machine Corp.

 779 Gears and Related Parts.* Photographs, data, uses. 4 pp. instru-Lec Corp.

 780 Stock Sprockets.* Roller-chain units in five chain sizes. Cotalog 2, 8 pp. Dayton Rogers Mfg. Co.

Assembly Components

- 604 Socket Screws. 6 pp. Bristol Co. 608 Threaded Fastener. 4 pp. Hi-Shear Corp. 618 Centrel-Knob Selection. Raytheon Co. 619 Lock Muts. 20 pp. Grip Nut Co. 621 Precision Springs. 16 pp. Associated Spring 623 Self-Locking Nuts. Kaylock Div., Kaynar Mfg.
- Co. Inc.
 630 Swage Nuts. 4 pp. Standard Pressed Steel Co.
 781 High-Strength Belt.* For temperatures to 1200
 F. Form 2717, 4 pp. Standard Pressed Steel Co.

Manufacturing Processes, Parts

- 603 Arc-Welding Products. 40 pp. Lincoln Electric
- Co. 643 Wire und Strip Construction. 24 pp. E. H. Titchener & Co.

Materials

- 602 Stainless Steel. 12 pp. Universal-Cyclops Steel
- Corp.
 605 Polyester Resins. 4 pp. Plastics & Resins Div.,
 American Cyanomid Co.
 606 Fire-Resistant Materials. 4 pp. Spaulding Fibre

- 606 Fire-Resistant Materials. 4 pp. Spoulating Fibe-Co.
 607 Technical Ceramics. 8 pp. American Lava Corp.
 619 Steel Tubline. 8 pp. Ohio Seamless Tube Div.,
 Copperweld Steel Co.
 611 Preimpresented Materials. 8 pp. Prepreg Div.,
 Society of the Plastics Industry Inc.
 626 Silicene Uses. 8 pp. Silicone Products Dept.,
 General Electric Co.
 627 Carbon-Graphite Materials. 8 pp. National Carbon Co., Div., Union Carbide Corp.
 631 Silver-Brazine Alleys. 24 pp. Air Reduction
 Sales Co., Div., Air Reduction Co. Inc.
 634 Aerospace Materials. 8 pp. Westinghouse Electric Corp.
 636 Gless Products. 18 pp. Kopp Glass Inc.
- fric Corp.

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 782 Silicene Bata.* Uses for consumer and industrial products. 16 pp. Silicones Div., Union Carbide Corp.

 783 Polyester Resins.* Characteristics of 24 Laminac formulations. 12 pp. Plostics & Resins Div., American Cyanamid Co.

 784 Industrial Ceramics.* Photographs, descriptions of complete line. 20 pp. Saxonburg Ceramics Inc.

- of complete line. 20 pp. Jacobson's line.

 785 Laminated Plastics.* Bosic application and engineering data for 21 grades. 8 pp. Taylor Fibre Co.

 786 Aluminum Selection.* Alloy sheet, coil, and blank data summorized. 6 pp. Fairmont Aluminum Co.

 787 Glass, Glass-Ceramics.* "This is Glass"—history and bosic types. 68 pp. Corning Glass Works.

 788 Nylon Extrusions.* Industrial tubing, pipe, rod, strip. Form 217, 8 pp. Danielson Mfg. Co.

Engineering Dept. Equipment

- 641 Pressure Transducer. 4 pp. Fairchild Controls
- Corp.

 Corp.

 789 Drafting Film.* Herculene polyester-based film.

 8 pp. Keuffel & Esser Co.

 790 Drafting Aids.* Tables, files, roll-tracing files.

 Catalog ADR-612, 32 pp. Hamilton Mfg. Co.

NEW PARTS, MATERIALS, ENGINEERING EQUIPMENT

Electrical, Electronic

- 648 Electric motor is permanent split-capacitor type.
- Redmond Co. Inc.
 654 Lead-aulfide photocells are all-glass, hermetically sealed units. Cetron Electronic Corp.
 657 Germanium tunnel diodes have tightly con-
- trolled low peak currents. Semi-conductor Prod-ucts Dept., General Electric Co.

 658 Digital readout mounts in 1 x 3.1-in. panel space. Datascope Corp.

 661 Actuator meter has speed of 270-280 rpm. Electro-Actuators Div., Omega Precision Inc.

 666 Silver-cadmium cells are sealed units in 0.1 to 300 amp-hr ranges. Yardney Electric Corp.

Descriptions start on Page 278.

- 667 Light-indicater modules are for use in instru-ment, computer fields, Industrial Components Div., Raytheon Co.
 679 Microminiature lemps are 1/16 and 1/10 in, long. Kay Electric Co.
 673 insulated thermostat incorporates a bimetal-actuated contact. Chatham Controls Corp.
 676 Impulse counter counts at up to 500 per

NEW PARTS, MATERIALS (Cont.)

minute. Automatic Timing & Controls Inc.

477 Switch light for use where two switching functions are needed. Elderma Corp.

480 Linear-meltin patentiemetres incorporate two tracks of conductive plastic. Markite Corp.

483 Ribben cable has wire bonded together. Westwood Cable Corp.

484 Serve mater-brake unit is controlled by an electromagnet. Instrument Div., Thomas A. Edison Industries. Serve merers. Instrument pres, edictromagnet. Instrument pres, edison Industries.

selectromagnet. Instrument Div., Inomas A.
Edison Industries snop or screw-on types.
Sealectra Corp.

499 Minieture pushbuttons are available in four new forms. General Electric Co.

591 Digital readeut has quick-disconnect terminal unit. Industrial Electronic Engineers Inc.

593 Bimetal disc thermestals have rapid response characteristics. Stevens Mfg. Co.

596 Mesnetic clutches, brakes have 80 oz-ln. output torque. Guidance Controls Corp.

597 Industrial Products Corp.

598 Industion mater maintains rotor alignment under shock. Brevel Products Corp.

719 Subfractional-hp maters have high starting torque. Alliance Mfg. Co.

720 Printed-circuit connectors resist vibration over 40 g. Matrix Science Corp.

731 Indicator-light capsules have three-color legend area. Radar Relay Inc.

732 General-purpose relay is small, four-pole, double-throw type. Potter & Brumfield, Div., American Machine & Foundry Co.

739 Pushbutton enclessures for 1 to 25 pushbuttons. Hoffman Engineering Corp.

730 Manual sterter for use with fractional-horse-power motors. Furnas Electric Co.

736 Fost switch for use in electronic equipment. Switchcraft Inc.

733 Adjustable-speed drive is rated 34 to 4 hp.

728 Taggle switch for use in electronic equipment. Switchcraft Inc.
733 Adjustable-speed drive is rated 34 to 4 hp. Square D Co.
734 Induction meter is a 1/100-hp unit. Kearfott Div., General Precision Inc.
736 Wire-wound resister has sealed resistance element. Rotohmeters Inc.
737 Trimming potentiemeter is subminiature unit for printed-circuit applications. Potentiometer Div., Doystrom Inc.
739 Time-delay relay is rated 100 ma to 10 amp. E-TA Products Co.
741 Penel meter is rectangular, all-metal unit. Helipot Div., Beckman Instruments Inc.
742 Power relay features an inverted coil. Guardian Electric Mfg. Co.

Hydraulic, Pneumatic

490 Vene-pump cartridge for use in many fluid systems. Vickers Inc., Div., Sperry Rand Corp.
456 Sheft seels can be assembled and disassembled by hand. Gits Bros. Mfg. Co.
460 Retery actueter produces 6.5 lb-in, torque at 120 psig. Ledex Inc.
42 Air-pressure resultar is accurate below 1 psig. C. A. Norgren Co.
43 Hydresulic swivel incorporates all-metallic seals. Propulsion Development Laboratories Inc.
465 Fuel filter trops dirt particles as small as 0.002 in. Tillotson Mfg. Co.
479 Weter puemps have noncorrosive construction. Tuthill Pump Co.
479 The Company of the Co

482 Diephraym pressure switches have standard body with interchangeable components. Barksdale Valves.
486 Air-hydraulic cylinder for machine-tool and automation applications. Sheffer Corp.
490 Pinch valve is positive-opening at low pressures. RKL Controls Inc.
692 Tube-pipe nipple fittings permit fitting in close quarters. The Lenz Co.
695 Tandem cylinders in 1½ to 4-in. bore sizes. Allenoir Corp.
700 Sheft-type eil seel for shaft sizes from ½ to 7 in. Chicago Rowhide Mfg. Co.
703 Lightweight unlen for missile and aircraft use. Harrison Mfg. Co.
709 Tubing valve for temperatures to 1000 F. Autoclave Engineers Inc.
710 Air power cylinders in 1¼ to 4½-in. bore sizes. Hannifin Co.
711 Flow meters for purge and low-flow uses. Devco Inc.
712 Sight-flow indicator permits checking fluid in pipeline. Schutte & Koerting Co.
712 Centrifugal pumps have capacities to 400 gpm and heads to 150 ff. Aurora Pump Div., New York Air Broke Co.
713 Flow machine Co.
714 Piper Co.
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717 Air cylinder is rated 200 psi. Ortman-Miller Machine Co.
718 Spiral mezzies are nonclogging units with In-

731 Spiral nezzles are nonclogging units with in-termediate capacities. Bete Fog Nozzle Inc.

732 Vertical pump-meter provides vibrationless operation. Reuland Electric Co.
735 Rubber hose assembly in ¼4 to 2 in. diam sizes. Titeflex Inc.
738 Flexible steam hose is corrosionproof and non-aging. Resistoflex Corp.
744 Sectional valve in part sizes from ½ to 1 in. Green Mfg. Co.

Mechanical Equipment

653 Variable-speed bettine in single or twin-link types. Lovejoy Flexible Coupling Co.
672 Speed reducers have ratings from fractional to 58.5 hp. Cleveland Worm & Gear Div.,

to 58.5 hp. Cleveland worm a own bit.,
Eaton Mfg. Co.
675 Sealed bearings operate continuously at 300 F
temperature. Barden Corp.
694 Terque-errin reducer develops high torque.
Dodge Mfg. Corp.
697 Lineer actuator in planetary and positive-type
drives. Roton Products Div., Anderson Co.
701 Hydraulic clutches handle torque loads from
1000 to 10,000 lb-ft. Rockford Clutch Div.,
Roce. Warner Corp.

1000 to 10,000 lb-ft. Rockford Clutch Div.,
Borg-Warner Corp.
724 Automatic clutch for 6 to 10 hp gasoline,
diesel engines. Salsbury Corp.
729 Drum-sprocket bruke for scooter-type vehicles.
Magneto & Engine Accessories Div., Fairbanks,
Morse & Co.
745 Limit steps, slip clutches in sizes 5 and B.
Northfield Precision Instrument Corp.

Assembly Components

645 Floating clinch nut is self-locking. Elastic Stop Nut Corp. of America. 646 Liquid-spring sheck absorbs 175 lb-in. energy in 1/10-in. stroke. Taylor Devices Inc. 649 Precision sheft locks for V₆ and V₄-in. shafts.

649 Precision shaft locks for V₆ and V₆-in. shafts. PIC Design Corp.
652 Plastic prefectors are used as caps or plugs. S. S. White Industrial Div.
659 Ministrue angle counter provides readings from 000.0 to 359.9 deg. Bowmar Instrument Corp.
646 Washer-base mut provides resilient tightening, locking action. Palnut Co., Div., United-Carr Fastener Corp.
668 Printing counter counts up to 5000 per minute. Radson Engineering Corp.
674 Large-flange rivet for use in relatively soft materials. Pop Rivet Div., United Shoe Machinery Corp.
685 Module fastener for multiple-pin connectors. Monadonck Mills.

Monadnock Mills.

704 Flange nut is combined nut and washer. Mac-Lean-Fogg Lock Nut Co.

706 Wood insert provides high strength in blind and through holes. Groove-Pin Corp.

Materials

- 447 Silicone rubber resists low temperatures. Silicone Products Dept., General Electric Co.
 551 One-component ceeting for electronic components. Columbia Technical Corp.
 655 Vinyl sheeting for vinyl-to-metal uses. Pennsylvania Div., General Tire & Rubber Co.
 681 Dry-film lubricant resists temperatures from —120 to +500 F. Fluoro-Plastics Inc.
 687 Aluminum pulley steck is 1/5-in. pitch stock in 8-in. lengths. H. Neuman & Co.
 99 Vinyl-glass tubling has continuous striped pattern. William Brand-Rex Div., American Enka Corp.

tern. William Brand-Rex Div., American Enka
Corp.
702 Phenolic laminate has excellent cold-punching
characteristics. Richardson Co.
705 Mylar laminate has good chemical and moisture resistance. Swedlow Inc.
707 Silicone-epaxy compounds for potting, caulking,
and encapsulation. Emerson & Cuming Inc.
708 Teflon sheet is available in large sizes. Polymer Corp.
715 Urethane foam for cushion, insulating, sealing.
Air-O-Plastic Corp.
720 Copper-clad laminates are fire-retardant, coldpunched types. Micarta Div., Westinghouse
Electric Corp.
723 Adhesive coating conducts static charges away
from metal, glass, plastic. Schwartz Chemical
Co. Inc.

Co. Inc.
730 Adhesive compounds bind fooms to fabrics, paper, metal foil. Alco Oil & Chemical Corp.
740 Synthetic-rubber adhesive bonds porous materials to metal. Bostik Dept., B. B. Chemical

743 Wound-epoxy tubing has high burst strength. Spaulding Fibre Co. Inc.

Engineering Dept. Equipment

746 Weldable strain same can be attached to aluminum alloys. Microdot Inc.
747 Self-centralined photocopier uses premixed developer in disposable cartridge. Transcopy Inc.
748 Tinted sensitive pagers for diazo printing process. Ozalid Div., General Aniline & Film Corp.
749 Miniature slip rims has manually operated brush lifter. Michigan Scientific Corp.
750 Engineer's notebook contains graph, tracing,

and data sheets. Tech-Form Co., Div., Martin Sweets Co. 751 Transister cards permit development of a vari-ety of circuits. Circuit Structures Lab. 752 Lettering set consists of 12 templates, scriber, and pen. Unitech Corp.

Traid.
754 Loboratory furnaces heat to 2300 F in 1½ hr.
L & L Mfg. Co.
755 Pressure transducer for temperatures from
-54 to +85 C. Giannini Controls Corp.
756 Oscilloscope bay consists of seven transistorized units. Electro Instruments Inc.

units. Electro Instruments Inc.
757 Table-model whiteprinter operates at speeds to
55 linear fpm. Paragon-Revolute Div., Charles
Bruning Co. Inc.
758 Freezing unit for temperatures as low as
— 200 F. Instrumentation Associates.

EDITORIAL ARTICLES

Single copies of the following articles are available as long as the supply lasts. Starred items are from previous issues. See Page 386 for other available reprints. Editorial content of MACHINE DESIGN is indexed in the Applied Science & Technology Index and the Engineering Index, both available in libraries. Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.

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9-2 Vinyl-Metal Laminates.* Selection and specification; solutions to assembly welding problems.
9-3 Technical Literature.* Techniques for weeding out material with limited value.

.9-5 Natural Frequencies of Multiple-Mass Systems.

Computing natural frequencies; solution for torsional frequencies of complex interconnected

9-6 Chemically Milled Structures.* Advantages and disadvantages of chemical milling; design of chemically milled parts.

9-7 High-Reduction Hypoids.* Types and applications; design of sets for ratios from 10:1 to 120:1.

9-8 Self-Checking Interpolation.* Finding on In-termediate value from values already tabulated for a nonlinear function.

8-1 Managerial Planning.* Plan-making methods

8-1 Managerial Planning.* Plan-making methods for engineering managers.
8-2 Pressure Regulators.* Basic principles and types; selection and application.
8-3 Elastic-Bady Mechanics.* New principles in using elastic properties of materials to solve

design problems. 8-7 Designing Cam Profiles.* Calculation of polynomial cam curves to fit mixed conditions of displacement, velocity, and acceleration.

7-1 From Engineer to Manager.* Six major routes to management.

to management.

7-5 Helical Spring Design.* A direct design procedure that eliminates trial and error.

7-6 Internal-Combustion Engines.* Factors in selecting engines up to 60 hp in size.

6-2 Conical-Disc Springs.* Designing for specific characteristics in minimum space.

6-3 Self-Sealing Couplings.* How to select air and hydraulic types for instant connection and disconnection without fluid loss.

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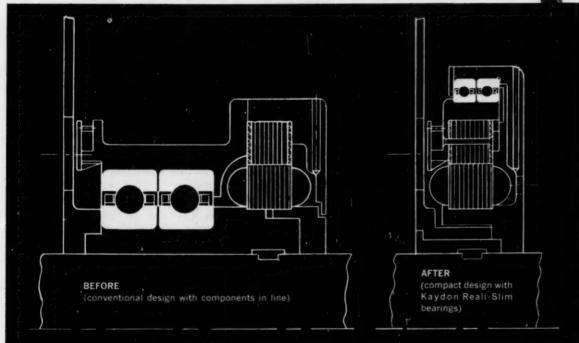
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Don't let in-line design get in the way of a compact product . . .

"NEST" COMPONENTS INSIDE THE BEARING BORE





Motor assembly redesign shown above is typical of the way Kaydon Reali-Slim bearings save space, reduce weight, cut costs!

Kaydon thin-section Reali-Slim bearings provide valuable component space inside the bearing bore. And use of a hollow shaft permits utilizing this space for control rods, linkages, collets, counter-rotating shafts, clutches and brakes, to name a few possibilities.

With Reali-Slim bearings, you save weight and space in both bearing and housing, reducing costs for materials, shipping, storage and handling.

And large-bore Reali-Slim bearings give closer support to the outer edge of rotating parts, instead of the center only, which gives more rigidity and accuracy for moment loads.

Stocked in 90 sizes! These Kaydon Reali-Slim Type CP bearings have Conrad deep-groove, ball-radial construction and new bronze, one-piece snap-over separator in 4" to 12" bore—1/4" to 1" width and cross section. Kaydon's volume production cuts prices up to 76%, depending on size.

Contact Kaydon now. Have the Kaydon sales engineer or distributor salesman in your area discuss Reali-Slim bearing applications for your products. Or write for free, fact-full "CP" bearing bulletin—with prices.

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All types of ball and roller bearings — 4" inside diameter to 178" outside diameter . . . Taper Roller Roller Thrust • Roller Radial • Needle Roller • Ball Radial • Ball Thrust • Four-Point Contact Bearings



K-609R

trends

engineering/personal

Engineering enrollment, on the skids nationally for some time, seems to be turning upward. At Cornell, freshman registration has jumped 10 per cent over last year, the first rise reported since 1958. This is well ahead of the national figure, which shows a rise of 1.2 per cent in the fall of 1960. U. S. Office of Education officials Wayne E. Tolliver and Dr. Henry H. Armsby comment: "There is an indication that within the next year or two, engineering enrollments may show the annual increases typical for this major field of study."

Headlines in the U. S. to the contrary, Russia isn't counting on research in pure science as the best way to catch up with the West. Emphasis, instead, is heavy in the areas of manufacturing techniques and applied engineering—a point well illustrated by exhibits at the International Trade Show, Poznan, Poland. In presenting this analysis to the Fifth Conference on Automation (sponsored by Purdue and AUTOMATION magazine), Professor O. D. Lascoe said he was impressed by the desire of Iron Curtain students to surpass the U. S.

products/processes



Brighter Flaw Lines

A new family of materials for magnetic-particle testing (visible and fluorescent) has been introduced by Magnaflux Corp. The concentrates give a 70 to 600 per cent increase in brilliance over older pastes. Most noteworthy feature, says Magnaflux, is the ease of preparing a magnetic-particle bath. Added to a measured quantity of oil, the powders give a uniform suspension almost immediately. Included in the line are four powders for the visible red or black (Magnaflux), four for the fluorescent method (Magnaglo).

The Assault on Salt

Salt-water to fresh-water converters still cost too much to run. Southern California Edison Co. reports first-year operating figures of \$1.92 per 1000 gal for taking salt out of sea water for its steam powerplant. Says Cal-Edison's R. W. Spencer: ". . . if fuel costs were miraculously reduced to zero, and the conversion plant were constructed with government money, water costs would still be too high for irrigation use."

research



Atomic Re-creation

A "dinosaur" of matter, one that decayed out of existence only weeks after the birth of the universe, has been recreated. Probably to be called Lawrencium (symbol Lw), the new isotope of the element 103 is the last of the actinide series and the first to be discovered solely by nuclear methods. Believed to have atomic weight of 257, Lw was created by nuclear chemists Albert Ghiorso, Almon E. Larsh, and Robert M. Latimer at AEC's Lawrence Radiation Laboratory, University of California.

AEC has earmarked \$19,900,000 for a high-temperature materials research program that will use some of the personnel and facilities released by cancellation of the nuclear aircraft engine. Distribution of funds is as fo'lows: General Electric Co., \$4,500,000; Pratt & Whitney, \$1,000,000; Oak Ridge National Laboratory, \$1,200,000. Remaining \$13,200,000 will be for development of a high-performance reactor.

Calcium and zinc molybdates equal or exceed the rust-preventive characteristics of red lead and other common inhibitors, says Battelle Memorial Institute. Since the molybdates are nontoxic, they could be used in food-processing machinery; since they're white, a one-coat corrosion-proofing and decorative finish is possible. Battelle is studying the molybdates for Climax Molybdenum Co.

Computers Present a Problem

Computer designers—racing to be first out with the fastest machine employing the latest technological gimmicks—have been complicating the product, cutting utilization, and raising rental fees too high. Burroughs Corporation's Earl Kendle told attendees at a recent Cleveland Engineering Society Computer Conference that today's computer-design problems fall in four key areas: 1. The man-machine communication barrier. 2. System expansion and contraction without costly reprogramming. 3. Utilization of the system as a whole, and as individual components. 4. Reduced necessity for human intervention.



For companies that don't own a computer, National Cash Register Co. offers a low-cost data-processing-by-mail service. The "package" program is built around the use of easily mailed punched paper tape as the basic input medium. Created on an inexpensive NCR tape unit used in cash registers and accounting machines, the punched tape can be sent to Data Processing Centers in New York City, Dayton, or Los Angeles. Analyzed on an NCR 304 computer, results are returned in 48 hours in most cases.

A new era in industrial automation, in which automatic controls in the plant will be "wedded" to data-processing equipment in the office, is shaping up, says George M. Muschamp, Minneapolis-Honeywell executive. He warns that the marriage must be brought off as an economical union, not as a costly collision. A first-order problem: Reorganization of paper work so that its information, besides serving as office records, can be fed automatically into the plant for automatic control of production.

materials

Plus Value for Carbon-Graphite

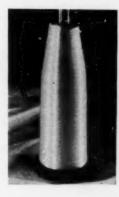
Additives, either organic or inorganic, have tremendous effects on performance of carbon-graphite seal rings—but the effects aren't generally recognized. This point was made to the 16th annual meeting of the American Society of Lubrication Engineers by Dr. D. Ramadanoff and J. J. Sherlock of National Carbon Co. They emphasized that additives act as boundary lubricants, reduce friction and wear, and increase oxidation resistance of the fine-grained carbon graphite.

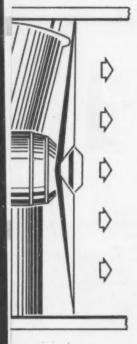
Adding only a trace of magnesium (0.04 to 0.05 per cent by weight) to a galvanizing bath improves corrosion protection 20 to 90 per cent, says Dow Chemical Co. Proving out the new process with a 6-year test program, Dow found no difficulty in adding or maintaining magnesium in a galvanizing bath. The coating produces a satin-white silver appearance which depends on the amount of aluminum present.

The "world's cleanest grease"—400 times cleaner than the best previously available—has been announced by Miniature Precision Bearings Inc., Keene, N. H. Called Minapure, the super-clean lubricant is intended for application in miniature instrument bearings. According to MPB, with test methods outlined by highest military specifications, no contaminants or dirt particles can be found in Minapure.

Filling in on Filaments

Recent test launching of a glass-filament-wound Polaris rocket motor signaled a "revolution in materials engineering." However, there is still development work to be done. Aerojet-General's R. A. Rawe rounded up the problem areas at a symposium of the Society of Aerospace Materials and Processing Engineers: Elimination of filament defects (crooked fibers), better understanding of the relative roles of resins and reinforcements, crazing effects. The need for standard test methods for evaluating filaments was underlined by W. Bandarik, Ford Motor Co.





Wind-tunnel testing, a nearly passe art in the aircraft industry, is beginning to intrigue truck designers. Drag imposed by the enormous flat frontal surfaces of a trucktrailer combination drains off a surprising amount of the vehicle's engine power. Fuel consumption is obviously affected.

As size and speed of turnpike-designed trucks increases, aerodynamic configuration (it may emerge as "styling") will undoubtedly increase in importance. More refined windtunnel studies are thus being scheduled: "Directional characteristics of truck-trailer trains in a side wind or gust" is a typical future project.



Truck Aerodynamics: More Power

IN SEEKING significant improvements in truck performance, designers usually concentrate on raising powerplant output and cutting vehicle weight. Results of their efforts are seen in the impending use of gas-turbine engines, and in the current use of aluminum frames and glass-fiber cabs. While research in these areas will continue to predominate, the next advancement in truck design may come from the industry's styling staffs.

The low, sleek shapes conceived by passenger-car stylists have often been defended on the basis of aero-dynamics: "They enhance a car's controllability, or reduce power-consuming wind resistance." Although these claims often originate with an enthusiastic sales organization, there is no doubt that in truck design, applied aerodynamics can pay off handsomely in terms of performance.

A thorough study of the problem at General Motors Corp.—revealed at a recent SAE meeting by Dr. Peter Kyropoulos and Harold Flynn, members of GM's research staff, styling—emphasizes the importance of streamlining:

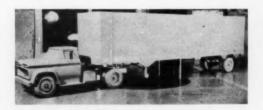
• At approximately 60 mph, rolling resistance and aerodynamic drag are equal. For a truck of 55,000 lb gross vehicle weight, these factors account for about 100 hp each.

• By merely changing the front shape of the trailer—from square to round—drag has been reduced 37 per cent.

More detailed application of aerodynamic principles will result, ultimately, in more miles-per-gallon for better-behaving over-the-highway trucks.

1960 Chevrolet truck-trailer combination (below) served as a base line for GM's studies. Choice of model scale was, as usual, a compromise between conflicting requirements. It is desirable to test the model at high Reynolds number, using as large a model as possible to achieve close correlation between model and full-scale data. However, with available tunnel facilities (GM used Guggenheim Aeronautical Lab's 10-ft tunnel at Cal Tech) anything approaching full scale was out of the question.

Data obtained by Kyropoulos and Flynn established a maximum ratio of model crosssection area to tunnel cross-section of 4 per

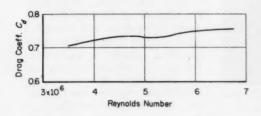




from Styling

cent. Accordingly, the Chevy truck-trailer was built to 1/12 scale, the smallest model that would provide accurate data and the largest that could be used without excessive tunnel interference. Model is mounted above the ground plane and "rides" on the boundary layer as the road.

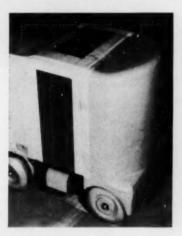
For all truck shapes tested, drag coefficient has proved essentially independent of Reynolds number. Tunnel speed, therefore, can be reduced to whatever is practicable, as long as Re is greater than 10^6 . Plot of the Chevy rig (below) illustrates the point: C_d rises slowly (from 0.71 to 0.74) as Re increases.



What's up front, particularly the shape thereof, may count heavily in determining a truck's power requirements. Typical models tested by GM researchers (below) illustrate the effects of good and bad aerodynamic styling. Percentage figures relate to the base-line model (1960 Chevrolet truck-trailer combination).



 $\triangle C_d = +1$ per cent



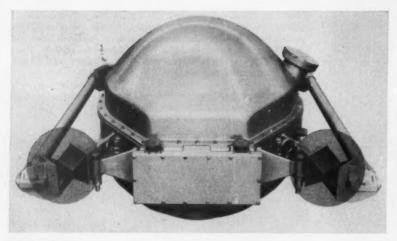
 \triangle C_d = -19 per cent



 \triangle C_d = -7 per cent



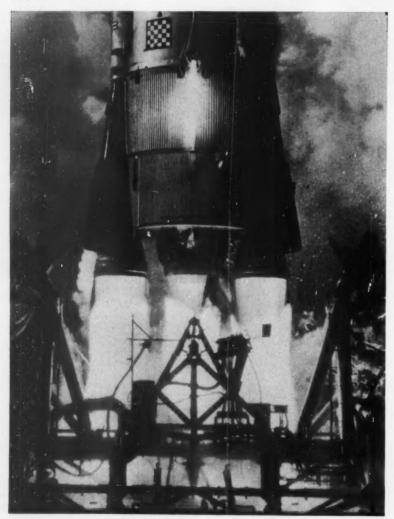
 \triangle C_d = +13 per cent



R. P. THORN
Supervisor, Electronics Group
Lord Manufacturing Co.
Erie, Pa.

Inertial guidance systems are an impressive example of design sophistication fostered by the missile age. In struggling from theory to workable hardware, they have helped solve many traditional design problems in other fields. As a typical example, look what they've done for vibration control . . .

Elastic Suspensions Protect Missile Guidance Systems



Four X-shape natural-rubber isolators protect the Atlas inertial platform (top picture). Symmetrically positioned around the platform's cg, the isolators are connected by tubular cross members. Weight of the entire operational suspension is about 13 lb; a fraction of the allowable weight spelled out in the specifications.

THERE are two basic types of inertial guidance systems: 1. Inertial, or gimballed stable platforms. 2. Body-mounted, or strapdown systems

• In the stabilized platform, accelerometers are held in their original angular orientation by a three or four-gimbal, servo-driven stable platform with three gyros. This provides instantaneous acceleration data along the three orthogonal axes of the original orientation.

• In the strapped-down system, the gyro system yields the necessary information concerning vehicle motion in inertial space. It merely acts as a transducer, relating the whole vehicle to an initial reference.

Severe vibration, noise, and sustained accelerations combine to produce a strenuous dynamic environment for both systems.

Random Problems

When the guidance art was young, designers considered only sinusoidal vibratory disturbances and sustained accelerations. As more instrumentation data became available, however, they found that random disturbances were more characteristic of the excitation produced by turbojet and liquid-fuel missile engines. This is an acoustical excitation which is transmitted through the vehicle structure and into the control compartment.

Solid-fuel engines introduce another component of excitation: A sinusoidal acoustical disturbance caused by resonant burning of the

See them at the Design Engineering Show, Booth 929-931



New idea-products for the creative designer

At CHAIN Belt Booth No. 929-931 in the Design Engineering Show you'll find a variety of new idea-products designed by Rex engineers to help increase efficiency and wear life, and cut costs, in the equipment you design. For example:

REX REDI-LUBE ROLLER CHAIN—a brandnew chain that lubricates itself.

REX SIDE BOW ROLLER CHAIN—a roller chain that can operate on curves, allowing new cost-cutting freedom in conveyor layouts.

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REX FIBRE-LITE SPROCKET—a new, low-cost, lightweight sprocket.

CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: Rex Chainbelt (Canada) Ltd., Toronto and Montreal.



fuel in the cavity. It has a discrete frequency and is superimposed on the random excitation.

Superimposed sustained accelerations ranging from a fraction of a g up to 25 g must be considered in the design of both systems.

Soft, but Stiff

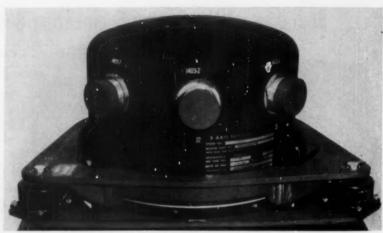
The basic requirement for a protective suspension is that it must have large linear capabilities to perform over a wide range of frequencies and sustained accelerations. Further, the suspension must maintain its capacity for protection despite static deflection resulting from acceleration. High-frequency characteristics are particularly important-this is the area in which troublesome structural resonances exist, and high structural responses can occur in the inertial-guidance system. Response characteristics of solid castings, gimbal rings, gyro rotors, and accelerometers combine to present a high-frequency problem unequalled in severity.

Experience has shown that elastomeric materials are ideal in this type of application-they provide more energy capacity, hence greater linearity, than classical systems such as mechanical spring-and-damper combinations. Also, damping and elasticity are combined in a single package which is compatible with tight-space applications. Another advantage in using an elastomeric suspension-elastic characteristics of the attachment points can be much more precisely controlled, both statically and dynamically, than is possible with hard mountings.

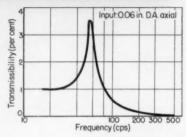
Weight is another area in which elastomers offer an advantage. A suspension that weighs 10 per cent of the supported weight is considered exceptional. The elastomeric system for the Atlas inertial platform weighs considerably less than 10 per cent of the supported weight.

Matched Set

Effectiveness of an elastomeric suspension system is determined by the performance of each isolator in the system. Properties must be identical so that characteristics of the system fall within the permissible tolerance. This does not necessarily imply customization of the elastomer, since standard production isolators are now used in ICBM inertial-platform suspensions.



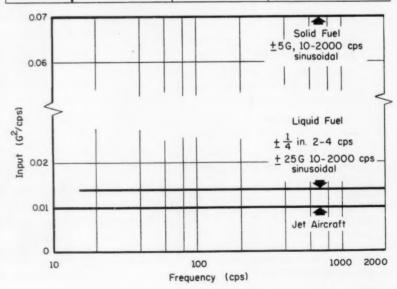
Titan reference system is suspended on three elastic mountings, dynamically matched to a total band width of 1.5 cps. Developed by Lord Mfg. Co., the mountings protect the system against simultaneous sinusoidal and random vibration ranging from 2 to 2000 cps, and against shock of 100 g (6 millisecond saw-tooth pulses). The mountings have a maximum transmissibility of 3.5:1 (curve, right). Suspension system weighs less than 2 lb and supports



45 lb. Mounting height is controlled to ± 0.001 in. Characteristic environments for other aeroscope craft are listed below:

CHARACTERISTIC ENVIRONMENTS FOR AEROSPACE CRAFT

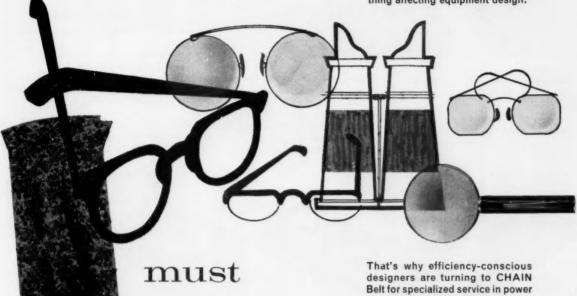
	JET	LIQUID-FUEL MISSILE	SOLID-FUEL MISSILE					
ENGINE VIBRATION	PURE RANDOM	RANDOM WITH SUPERIMPOSED SINUSOIDAL EXCITATIONS						
ACCELERATION	0-9	0-25G	0-25G					
SHOCK	MIL-E-005272B PROC. II	15-100 G 5-11 MSEC.	40-100G 1-11 MSEC.					
NOISE LEVEL	14046-16046	18046-20046	18041-20041					
TEMPERATURE	MIL-E-005272 B PROC. I	-100° TO 300°F	-100° TO 500°F					
NON-DYNAMIC	MIL-E-005272B PROC. 1	MIL-E-005272 B PROC. I	MIL-E-005272B PROC. I					



how many viewpoints

As if designing equipment in these competitive days wasn't enough, today's designers must view their creations through many eyes... management, production, purchasing, sales, service... and reflect the desires of each of these groups. And, most important, there's the customer!

The designer can be a specialist in many things, but it takes too much time to be an expert in everything affecting equipment design.



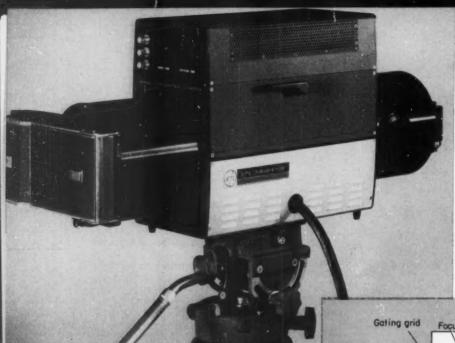
you reflect? drive and conveyor chains.

CHAIN Belt supplies not only Rex quality products but unequaled service to design engineers. Data on chain wear life and fatigue strengths that enable exact selection to fit requirements...actual field tests to serve as a definite guide to service expectations...even the designing of special chains to answer unusual conditions...are part of this specialized service.

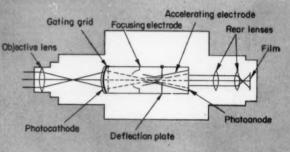
Why not take advantage of it! Call your CHAIN Belt Man or write CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: Rex Chainbelt (Canada) Ltd., Toronto and Montreal.

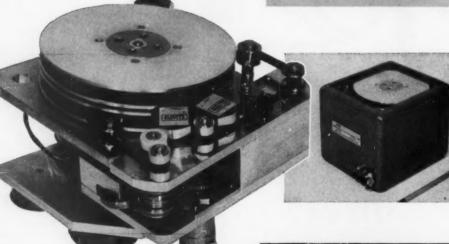
A CALL TO CHAIN BELT ADDS A MAN TO YOUR STAFF BUT NOT TO YOUR PAYROLL





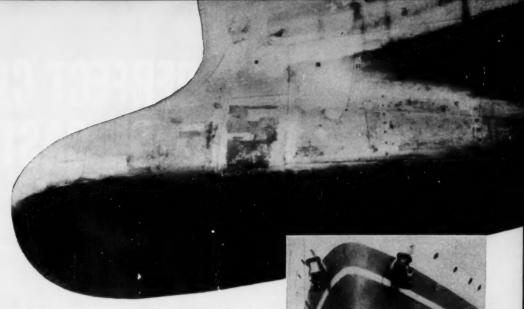
Snapping scientific photos at a 3-billion:h-second exposure time is well within the capability of this image-converter camera. According to the deve'oper, Space Technology Laboratories Inc., this is twice the speed offered by any other technique. The trick is in the conversion: The optical image of a luminous event is first converted to an electron image; shuttering, amplification, and focusing is then carried out by fast-acting electronic circuits. Reconverted to op:ical form, the brightened image is recorded on Polaroid or conventional film. Price of the unit: \$20,000.





Demands for recording on considerably less than one watt set a premium on power economy in the design of this miniature magnetic-tape unit. To minimize friction in the unique drive motor, Datalab Div. (Consolidated Electrodynamics Corp.) used brushes that roll rather than slide. An electronic speed control holds motor speed to better than ¼ per cent while consuming less than 40 milliwatts. Additional power-saving features: Thin-film (Mylar) belts, Neg-ator-spring reel tensioners, silicon-rubber capstans, a permanent-magnet erase system. Capable of recording for 2½ hr at 1 in. per sec, the unit has a reproduce frequency range of 1 to 25 kc.

A 5-hr recharge and this battery-powered drill is ready to bore seventy-five ½-in. holes in ¾-in. fir. Developed by Black & Decker, Towson, Md., the new "cordless" tool will reach the market in early fall, will cost about \$50. Except for describing housing materials (aluminum die castings and Cycolac plastic), and hinting at a "completely new concept" in motor design, B&D is sitting tight on details.



Drawing a ship's underwater bow lines forward into a "snout" can virtually eliminate wave drag, cut power requirements by 10 to 25 per cent. To prove out his theory, Tokyo University's Prof. Takao Inui built the bulbous bow onto this 3000-ton inter-islander, the KURENAI-MARU. Measured against an unmodified sister ship, the test vessel held an 18-knot speed with 10 per cent less power. University of Michigan experts, impressed by the development, are according it "apparent breakthrough" status. The Department of Naval Architecture will translate and publish Professor Inui's reports, also plans supplementary research, possibly with Navy backing. Among problems yet to be solved: Effects of heavy seas on the snout.

ENGINEERING NEWS PICTURE REPORT

Ultrasonic energy replaces heat and adhesives in Sonoseal—a new production machine for welding plastic films in the polyester group. The developer, International Ultrasonics, Cranford, N. J., says that 90 to 100 per cent of the original material strength is retained. Besides making hermetic plastic-to-plastic seams, the ultrasonic machine welds plastics to paper, cardboard, or cloth. It ignores surface water, oils, photographic emulsions, and abrasives.



A 12-hr recharge (through a built-in trickle unit) readies this compact electric for an 8-hr shift. Powerplant is a special 12-v motor operating from a single lead-acid battery. Without the trailer, the 182-Ib car will haul its driver plus a 100-lb load; the trailer carries 250 lb. Called the Delwick, the industrial vehicle is marketed by Namisco Inc., Springfield, N. J. Prices: Car, \$395; trailer, \$49.50.

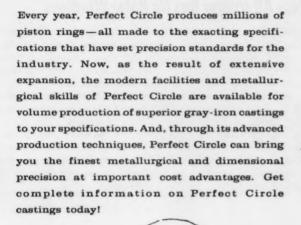


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Molds of carefully-controlled green sand are made from the pattern plate, and stacked for pouring. In the example shown at right after shake-out, the castings are 6-up in a stack 20 molds deep. Typical castings produced by this Perfect Circle process include piston rings, thrust plates, valve lifter facings and piston groove inserts.

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Circle 216 on Page 19

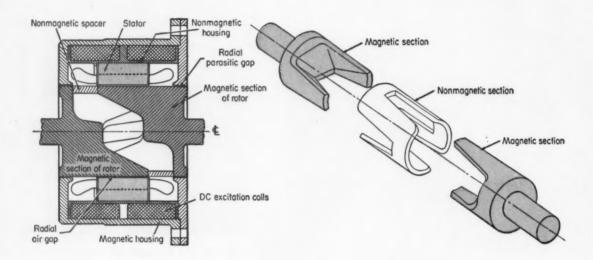


Nonmagnetic section of the rotor separates two magnetic end pieces. When the rotor is assembled, induced north and south poles are spaced 90 circular degrees apart, eliminating the need for rotating windings, rectifiers and slip rings.

Brushless Alternator Has No Rotor Windings

CLEVELAND—A new high-speed alternator, developed by Thompson Ramo Wooldridge Inc., Tapco Group, generates electrical power without resorting to rotating windings, rectifiers, or slip rings. Electromagnetically excited, the device performs its best under the adverse environmental conditions encountered in aircraft, missile, and space applications.

The unique one-piece smooth-surface rotor offers many advantages, according to TRW engineers. Cooling requirements are held to a minimum, eliminating the need for auxiliary cooling equipment. The rotor doesn't have to be cooled at all, and the stator can be easily cooled with gas or liquid. In addition, the alternator is extremely light weight—about 2 lb per kva—and can be made lighter if "advanced" magnetic materials are used in the rotor. Compared to other alternators, efficiency is high (85 per cent) and motor characteristics are excellent.

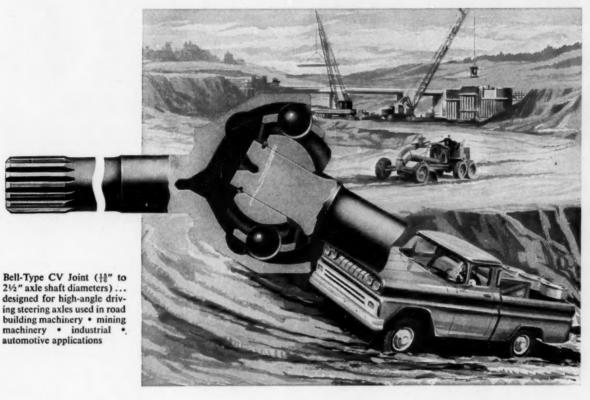


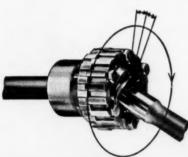
Flaws in 4-In. Steel Pictured on TV

Minute cracks in thick steel plates and other dense objects can be instantly detected by a new gamma ray image intensifier system. Developed by Rauland Corp., subsidiary of Picker X-Ray Corp., the system permits continuous assembly-line inspection of materials that could previously only be checked by gamma-ray photographs. An operator, sitting in the control room, watches slabs of steel on a TV screen. As the steel moves along a conveyor, the operator can determine the exact location of each flaw and shear off only as much steel as is necessary to cut out the defective section. Experiments indicate that the inspection method can effect substantial economies—one steel mill estimates savings of nearly \$700,000 per year through speedup of its inspection operations.



CON-VEL (RZEPPA) CV Universal Joints Give Longer Life, Higher Torque Capacity!





Disc-Type CV Joint (from 21/8" to 161/4" swing diameter)... designed for all types of industrial drive applications. Rzeppa Joints always transmit torque smoothly, even at unbalarzed angles. Note constant velocity of 100% for Rzeppa Joint.







During rotation at a given angle, pin or slipper-type joints speed up, slow down twice during one revolution, as shown by the solid line in the graph.



CON-VEL DIVISION

DANA CORPORATION

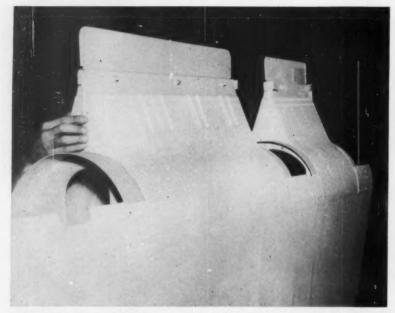
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for your free copy of this new engineering data folder on the complete line of Rzeppa constant velocity joints.



Uranium Weights Balance Airfoils

Heavy Material Lightens an Aircraft



Leading edge of the rudder for a Convair 990 bears uranium weights which move the center of gravity far forward and allow the rudder to be balanced about its hinge pin with a minimum of additional material. Although marked radioactive, the weights are safe to handle. Fissionable materials have been removed and cadmium plating protects the handler against any lingering alpha radiation. SAN DIEGO—Aircraft weight is reduced nearly 65 pounds in the Convair 990 by using heavyweight uranium (density 1.65 times that of lead) for control counterbalance weights. Flight surfaces are balanced by adding the uranium weights forward of the hinge line. The heavy weights move the center of gravity forward without changing clearance to fixed wing and tail surfaces. Moving the center of gravity forward increases the lever arm of the mass and thus reduces the total weight required.

Depleted uranium that is used (largely U-238) is less radioactive than the natural material. Although the weights are marked "Caution—Radioactive Material," they are completely safe to handle. They are cadmium plated to reduce oxidation and dusting. The plating acts as a shield for all alpha and some beta radiation.

Before uranium became available, lead and tungsten had been used for counterweights. Sintered tungsten was used in the Convair 880. Although comparable in price, uranium is 11 per cent more dense than tungsten and, correspondingly, less of it is required.

Winners Announced in Sintered Parts Contest

New York—Entries in the "Non-ferrous Metal Powder Part of the Year" ranged from toggle links to fire-alarm pull boxes. Each item demonstrates one or more unique qualities of sintered parts that could not be achieved by other production methods. Sponsor of the contest, New Jersey Zinc Co., New York City, says that competition was close. In addition to the Grand Prize winner (below) and three runners up (right), eight entries received awards of merit.

Properties of brass powders were exploited in design of fire-alarm mechanism. The assembly is tough to withstand impact loading and is self lubricating for smooth operation. It was designed by S. H. Couch Co., N. Quincy, Mass.

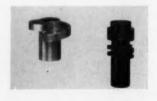


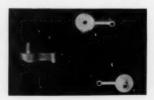
Deceptively simple appearance hides unique design of a d-c motor armature. Green inner compact of bronze is internested with a green outer compact of iron powder. After sintering, the outer member is machined away, leaving only the magnetic points imbedded in the copper. The armature is produced by Kwikset Powdered Metal Products, Anaheim, Calif.

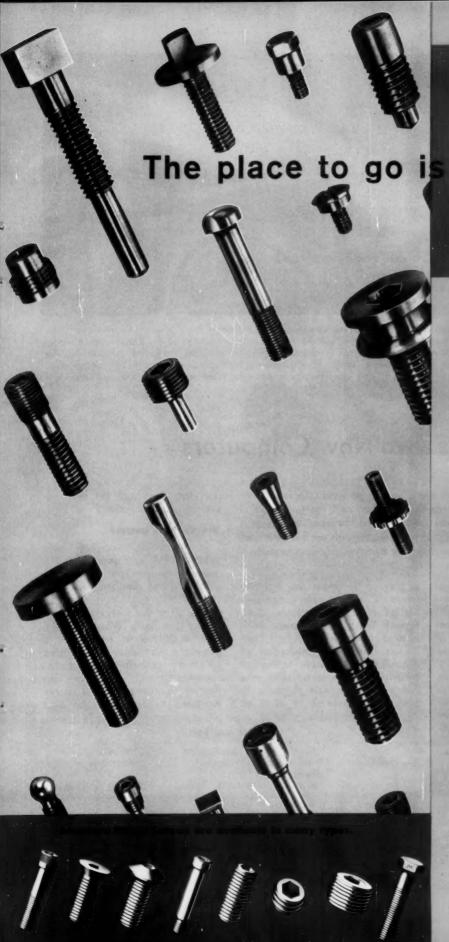
Sliding characteristics of oil-impregnated sintered bronze enhanced the design of this distributor cam. Used in an automatic pin-spotting machine, the cam is made by International Powder Metallurgy Co., Ridgeway, Pa.

Phonograph motor toggle link is made of sintered bronze. It forms a free-floating surface for the drive disc, and provides a cam surface to shift the idler wheel up and down a stepped pulley, producing three-speed operation. It was designed by American Powdered Metals Inc., North Haven, Conn.











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produced and delivered on time

Mac-it Fastener Engineering Service will give you practical and professional assistance in developing any type of threaded fastener.

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And our service on standard alloy steel screws, like our service on specials, is geared to provide the same prompt action. Call Mac-it Engineering Service or contact your nearby Mac-it distributor for all your needs in alloy steel screws.

MAC-IT PARTS COMPANY



Five years in development, the Stretch computer will simulate a complete hydrogen-weapon test in less than one week of calculation. The machine will make 250 billion calculations to analyze the propagation of shock waves and their effect; determine the intensity of radiation, and examine the fallout, taking into consideration the varying

meteorological conditions likely to occur. Conventional largescale computers now installed at Los Alamos would require several months to complete the same computation. The Stretch system's high-speed capabilities will permit scientists to simulate far more realistic weapons' tests than ever before possible.

IBM Graduates Two New Computers

WHITE PLAINS, N. Y.—If your design-engineering problem calls for a computer that can add 670,000 fourteen-digit numbers in 1 sec (and price is no object), consider Stretch—International Business Machines' latest assault on the limits of computer technology. If your requirements are more leisurely—say, 83,300 additions per sec—perhaps the company's newest production model, the 7072, will be adequate.

Stretch, acknowledged to be the world's most powerful and versatile computer, is a custom-engineered system that is currently the only one of its type; IBM 7072 is a "production" model that rounds out the already famous 7070/7074 line of high-speed, automatic data processors. Stretch will do 24 four-teen-digit multiplications while 7072 does one involving ten-digit numbers, but a Stretch system costs "upwards of \$10 million" while 7072 sells for a mere \$860,550 (it rents for under \$20,000 per month).

Tailored for AEC

Stretch was designed for the Los Alamos Scientific Laboratory, and is now operating at that key nuclear research center. Working with 14-digit numbers, the system is capable of performing 30 billion multiplications in a 24-hr period. It is destined

to play an important role in many advanced projects such as the simulation of hydrogen-weapon tests, Project Rover (development of a nuclear-power rocket engine), and Project Sherwood (production of controlled power from thermonuclear-fusion. According to IBM, the computer will enable physicists to work with equations so advanced

that they have not yet been expressed mathematically.

New Concepts Involved

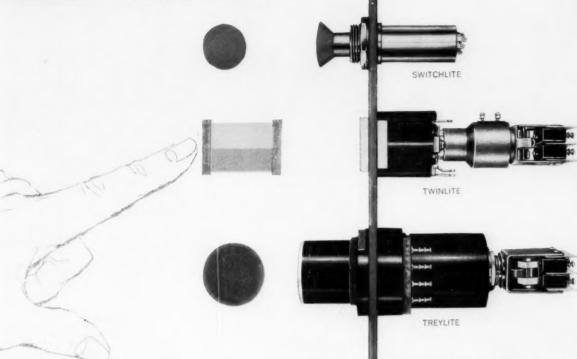
In "stretching" computer technology, IBM engineers have developed new concepts in multiprogramming and simultaneous operations:

• The computer works on an assembly-line basis. When one element completes its assignment, it passes the work along and starts on a second problem—although the computer is still solving the first problem in other parts of its system. As many as nine programs have

Ultrafast and Faster

Assignment	Size of Numbers Processed	Time Required (mu sec)		Processing Speed (operations per sec)	
	(digits)	IBM 7072	Stretch	IBM 7072	Stretch
Add/subtract	6 and 6	12		83,300	
	14 and 14		1.5		670,000
Multiply	10×10	64		15,600	
	14×14		2.7		370,000
Divide	20 by 10	94		10,500	
	14 by 14		10		100,000

CUT CONTROL PANEL COSTS AND SAVE SPACE WITH COMBINED SIGNAL & SWITCH



The most modern control panel designs combine indicator lights and pushbutton switches wherever possible. This cuts costs by reducing the number of components, and speeds assembly. Overall panel size can often be reduced as much as 75%. And these "human-engineered" controls sell better because operation is obviously simplified. Here are just three of the many lighted pushbuttons available from Control Switch Division...

SWITCHLITE Model J8003 shown is a single lamp, D.P.D.T., push-push. Independent lamp circuit for 6, 14 or 28 volts. Rated 3 amp res., 1 amp ind. @ 28 VDC or 115 VAC. Mounts in %" dia. hole. 4 button styles, several lens colors.

TWINLITE... two lamps with independent circuits for 2-color lighting. Lens 1" x .740" in solid or split colors, with or without name-plate slot. Momentary or push-push action, or solenoid-held switch shown above. Rated 4 amp res., 2.5 amp ind. @ 30 VDC; 5 amp @ 125/250 VAC. Mount in groups or singly, using barriers.

TREYLITE . . . three independent lamps, each with color filter so three colors can be sequenced on white pushbutton screen. D.P.D.T. switch rated 4 amp res., 2.5 amp ind. @ 30 VDC; 5 amp @ 125/250 VAC. Select momentary or push-push action. Models for flush-panel mounting (shown above) or subpanel mounting.

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Waterman Series 1407 is a group of compact, fow-cost, pressure-compensated flow regulators, adjustable over a series of unusually wide flow ranges, for convenient on-the-job speed control of hydraulic cylinders and motors.

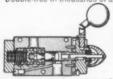
Rated for pressures to 5000 p.s.i.

Controlled flow to 40 g.p.m.—ideal for hydraulic motors as well as cylinders. Factorytested to 10% tolerance.

Wide range of adjustability—turndowns of as much as 80 ; 1.

Choice of mountings and operating devices. 1/2" N.P.T.F. size meets most needs—standard sub-plate mountings available.

Compact and light in weight—proved to be trouble-free in thousands of applications.





1002.

Unit senses pressure drop across variable erifice and reacts to control flow within desired limits.

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ENGINEERING NEWS



Customer-engineer's console (above) permits all units of the new IBM 7072 computer to be tested from a central point. The console is only one of the unique features of the new data-processing system designed for computational work in nuclear engineering, design automation, stress analysis, and other advanced fields. Magnetic tapes containing binary data (such as might be obtained in wind-tunnel tests) can be fed into the computer directly (right). Binary data is automatically converted into decimal information by the computer, permitting engineers to process data for immediate use.



 A look-ahead device anticipates instructions and data requirements of the system, greatly boosting the effective memory speed. The unit acts as a reservoir, lining up instructions and information to be processed a fraction of a second before they are needed.

• The computer can put aside what it is doing and turn to special tasks requiring immediate attention. These interruptions might be priority problems fed into the system or they might be caused by internal conditions recognized by the computer itself as worthy of special attention. After the special task is completed, the interrupted circuits return to their earlier task.

Design for General Engineering

The 7072 computer is primarily intended for engineering and scientific calculations, although it also provides broad data-processing ca-



pabilities for business. The system is designed for problems that require powerful computing ability, rather than the extremely high data input and output speeds that are features of machines designed for business calculations.

The IBM 7072 will be able to process magnetic tapes recorded during engineering tests, even though test language differs from that of the computer. Binary data is entered directly; the computer automatically converts it into decimal form.

Typical scientific and engineering problems that will be handled by the 7072 are:

- Creation of mathematical models to test product designs, systems, and operation theories.
- Simulation of space-flight vehicle trajectories.
- Design of nuclear reactors and supersonic aircraft.
- Analysis of products and structures to determine their ability to withstand stress.

MACHINE DESIGN



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Why are there so many parts molded of IMPLEX®, the high-impact acrylic, and PLEXIGLAS® acrylic plastic on the 1961 Ramblers? Here are the reasons.

IMPLEX is used for metallized armrest supports because of its superior toughness... for air conditioner housings and grilles because of its excellent appearance, its strength and good moldability in thin sections... for radio, window crank and gear shift knobs because of its dimensional stability and stain resistance.

PLEXIGLAS is used for tail light, back-up and parking light lenses because of its outstanding optical properties and weather resistance . . . for the speedometer dial because it calls for edge-lighting . . . for medallions and

other ornaments because the *crystal clarity* of PLEXIGLAS gives depth and sparkle to back-surface decorations.

The properties of these Rohm & Haas molding materials may well benefit a part on which you are working. Our design staff will be pleased to help you use PLEXIGLAS and IMPLEX to your advantage.



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In Canada: Rohm & Haas Co. of Canada, Ltd., West Hill, Ontario

All here...

components that satisfy

all pressure/flow system needs

IMPERIAL JASTMAN

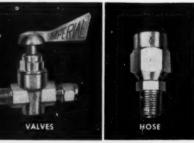
Now together, Imperial-Eastman meets all your hydraulic-pneumatic-flow component needs: tube fittings, valves, couplings, flexible and rigid hydraulic lines, thermoplastic tubing and tubing tools.

This *engineered* line gives you the exact product for every type of service condition—and the tools to make sure your assemblies are absolutely right.

For added satisfaction at your point of order, Imperial-Eastman products are available through highest caliber distributors.

For complete information, write for Catalog No. 101.







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When we say your most complete line of pressure flow system components for all hydraulic, pneumatic, instrumentation and other applications—here's what we mean:

TUBE FITTINGS OF EVERY TYPE AND SIZE—FOR ALL PRESSURES, TEMPERATURES

 Hi-Seal® Butt Joint Fittings, Braze-Seal Hi-Pressure, Hi-Duty, 37° Flare, 45° Flare, Flareless, Flex, Compression, Inverted Flare, Threaded Sleeve and Plastic Tubing Fittings.

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 Needle, Toggle, Diaphragm, Plug, Blow-Down and Kwik-Connect Types for pressures up to 5000 psi.

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- Medium-Pressure Hose and Tube Assemblies, Couplings and Fittings for One-Wire Braid Hose
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- All Synthetic-for Pressures up to 3000 Lb.
- · Adapter Unions, Adapters and Tube Fittings

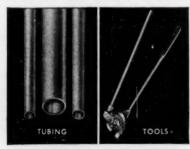
TUBING

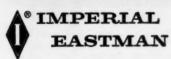
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No doubt about it now—see your Imperial-Eastman distributor first for all hydraulicpneumatic-flow system components.





Chicago 48, Illinois

Meetings and Shows

May 18-

Work-Factor Associates of the Midwest. Semiannual Meeting to be held at McCormick Place, Chicago. Additional information is available from Ted Stuart, 9401 W. Grand Ave., Franklin Park, Ill.

May 21-23-

Fluid Controls Institute Inc. Annual Meeting to be held at the Cloister, Sea Island, Ga. Further information is available from FCI headquarters, P. O. Box 667, Pompano Beach, Fla.

May 22-24

National Telemetering Conference to be held at the Hotel Morrison, Chicago. Sponsors are Institute of the Aerospace Sciences, Institute of Radio Engineers, Instrument Society of America, American Rocket Society, and American Institute of Electrical Engineers. Additional information can be obtained from IAS, 2 E. 64th St., New York 21, N. Y.

May 22-25-

Design Engineering Show and Conference to be held at Cobo Hall, Detroit. Conference is sponsored by the Machine Design Div. of ASME. Further information is available from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

May 22-26-

American Society of Tool and Manufacturing Engineers. Convention and Tool Exposition to be held at the Coliseum, New York. Additional information is available from ASTME headquarters, 10700 Puritan Ave., Detroit 38, Mich.

May 22-26-

Society of Photographic Scientists and Engineers. National Conference to be held at the Arlington Hotel, Binghamton, N. Y. Further information can be obtained from SPSE, Box 1609, Main Post Office, Washington, D. C.

June 1-2-

American Standards Association. Company Member Conference (open to all organizations interested in company standardization programs) to be held at the Pick-Congress Hotel, Chicago. Further information can be obtained from ASA headquarters, 10 E. 40th St., New York 16, N. Y.

Tune 4-8-

American Nuclear Society. Annual Meeting to be held at the Penn-Sheraton Hotel, Pittsburgh. Further information can be obtained from O. J. DuTemple, 86 E. Randolph St., Chicago 1, Ill.

June 4-9-

Society of Automotive Engineers Inc. Summer Meeting to be held at the Chase-Park Plaza Hotel, St. Louis. Additional information is available from SAE, 485 Lexington Ave., New York 17, N. Y.

June 5-7-

American Gear Manufacturers Association. Annual Meeting to be held at the Homestead, Hot Springs, Va. Further information is available from AGMA headquarters, 1 Thomas Circle, N.W., Washington 5, D. C.

June 5-9-

Society of the Plastics Industry Inc. Ninth National Plastics Exposition and National Plastics Conference to be held at the Coliseum and the Commodore Hotel, New York. Additional information can be obtained from SPI headquarters, 250 Park Ave., New York 17, N. Y.

June 6-8-

Instrument Society of America. Summer Instrument - Automation Conference and Exhibit to be held at the Royal York Hotel and Queen Elizabeth Hall, Toronto, Ont. Further data is available from ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

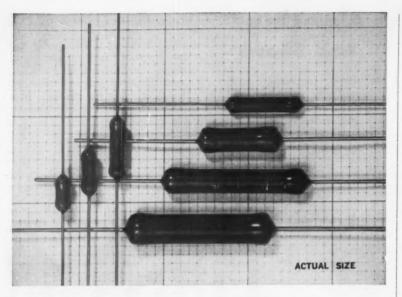
June 8-9-

Malleable Founders Society. Annual Meeting to be held at the Broadmoor, Colorado Springs, Colo. Additional information can be obtained from society headquarters, 781 Union Commerce Bldg., Cleveland 14, Ohio.

June 8-9-

National Electrical Manufactur-





THESE "WIRE-WOUNDS" ARE CIRCUIT SHRINKERS..... newly

expanded line lets AXIOHM® power resistors go into smaller circuits!

Ward Leonard AXIOHM power resistors are now available in *seven* sizes—down to 2 watts, up to 12.5.

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complete range of resistance values (see table) from 0.1 to as high as 75,000 ohms. Naturally, they feature the qualities Ward Leonard has made famous in power resistors:

Vitrohm vitreous enamel; Ward Leonard's specially made ceramic core; specially selected and matched resistance wire; and strong, permanent, low-resistance, spot-welded, lead-to-end-cap junctions.

100	SIZES AND RATINGS						
1 200	Rating	Rating Type Ro		Resistances (ohms)		s (inches)	
	(in watts)	туре	Min.	Max.	Length*	Diam.	
	2	2X	0.1	5,000	3/6	3/16	
	3	3X	0.1	10,000	1/2	3/6	80
	4	4X	0.1	15,000	11/16	3/16	883.
460	5	5XM	0.1	20,000	15/6	3/16	
	7	7X	0.1	25,000	1	3/16	
3 686	10	10XM	0.1	50,000	13/4	5/16 3/8	
D THE	12.5	12.5X	0.1	75,000	13/4	3/8	

*Less leads.

Get complete details in Supplement C to Catalog 15. Write for your copy and a list of stocking distributors today. Ward Leonard Electric Co., 58 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)



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RESISTORS . RHEOSTATS . RELAYS . CONTROLS . DIMMERS

ers Association. First Western Conference to be held at the Biltmore Hotel, Los Angeles. Further information is available from NEMA, 155 E. 44th St., New York 17, N. Y.

June 11-15-

American Society of Mechanical Engineers. Summer Annual Meeting to be held at the Statler Hilton Hotel, Los Angeles. Additional information can be obtained from ASME Meetings Dept., 29 W. 39th St., New York 18, N. Y.

June 13-15-

Institute of the Aerospace Sciences — American Rocket Society. Joint Summer Meeting to be held at the Ambassador Hotel, Los Angeles. Further information is available from IAS, 2 E. 64th St., New York 21, N. Y.

June 14-16-

American Society of Mechanical Engineers. Applied Mechanics Conference to be held at Illinois Institute of Technology, Chicago. Further information can be obtained from ASME Meetings Dept., 29 W. 39th St., New York 18, N. Y.

June 18-23-

American Institute of Electrical Engineers. Summer General Meeting to be held at Cornell University, Ithaca, N. Y. Annual Meeting of of AIEE begins June 19. Additional information can be obtained from AIEE headquarters, 33 W. 39th St., New York 18. N. Y.

June 19-21-

Institute of the Aerospace Sciences. Heat Transfer and Fluid Mechanics Institute, to be held at the University of Southern California, Los Angeles. Additional information is available from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

June 25-28-

American Society of Agricultural Engineers. Annual Meeting to be held at Iowa State University, Ames, Iowa. Additional information is available from society headquarters, 420 Main St., St. Joseph, Mich.

June 25-30-

American Society for Testing Materials. Annual Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. Further information is available from ASTM, 1916 Race St., Philadelphia 3, Pa.

June 26-27-

Fifth Annual Conference on Vacuum Metallurgy, sponsored by American Vacuum Society and New York University, to be held at University Heights campus of N. Y. U. Further information can be obtained from society headquarters, P. O. Box 1282, Boston 9, Mass.

June 26-28-

Institute of Radio Engineers. National Convention on Military Electronics to be held at the Shoreham Hotel, Washington, D. C. Further information is available from IRE, 1 E. 79th St., New York 21, N. Y.

June 26-30-

American Institute of Electrical Engineers. Aerospace Transportation Conference to be held at the Benjamin Franklin Hotel, Philadelphia. Additional information is available from AIEE, 33 W. 39th St., New York 18, N. Y.

June 28-30-

Second Joint Automatic Control Conference to be held at the University of Colorado, Boulder, Colo. Sponsors are Instrument Society of America, American Institute of Electrical Engineers, American Society of Mechanical Engineers, Institute of Radio Engineers, and



"Now that looks like an idea we can afford. It won't work, of course."



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Pumping hot oil up to 500° F.



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Diesel engine lube oil pump integrally mounted



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Pump delivers asphalt on road distributor



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See Our Exhibit at the Booth #1231, Cobo Hall,



Design Engineering Show Detroit, May 20-25

ENGINEERING NEWS

American Institute of Chemical Engineers. Further information is available from ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Short Courses and Symposia

May 23-

Seminar on Hydraulic Fluids to be held at the Milwaukee School of Engineering, Milwaukee. Further information can be obtained from Mel Striegel, Milwaukee School of Engineering, 1025 N. Milwaukee St., Technology Park, Milwaukee 1, Wis.

May 25-26-

Engineering Institute on Plastic Films to be held at the University of Wisconsin. Additional information can be obtained from Engineering Institutes, 3030 Stadium, University of Wisconsin Extension, Madison 6, Wis.

May 29-June 10-

Advanced Techniques of Programming Digital Systems-Mathematics, short course to be held at the University of California, Los Angeles. Course will deal with available techniques of programming and controlling digital systems, new research in the field of computer science, and new trends and problems arising both from new tendencies in the logical design of computer systems and from applications of digital systems to new fields. Further information is available from H. L. Tallman, Physical Sciences Extension, Room 6501 Engineering Bldg. II, University of California, Los Angeles 24, Calif.

June 8-9-

Engineering Institute on Practical Heat-Treating Fundamentals to be held at the University of Wisconsin. Further information can be obtained from Engineering Institutes, 3030 Stadium, University of Wisconsin Extension, Madison 6, Wis.

June 11-16-

Seminar on Electrical Contacts to be held at Pennsylvania State University. Theory and practice in electrical contacts, including static contacts and commutation, and arcs and arcing contacts, will be covered. Additional information is available from the Conference Center, Pennsylvania State University, University Park, Pa.

June 11-23-

Short Course on Solid-State Mechanics to be held at Pennsylvania State University. Major emphasis of the course will be on discussions of recently developed methods for evaluation and interpretation of stress-strain properties and the use of these procedures in design. Further information is available from the Conference Center, Pennsylvania State University, University Park, Pa.

June 12-

Air Pollution Instrumentation Symposium, sponsored by Instrument Society of America and Air Pollution Control Association, to be held at the Hotel Commodore, New York. Further information is available from ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

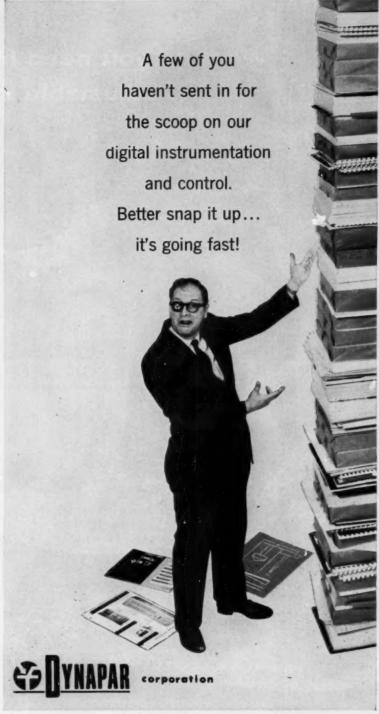
June 13-16-

Industrial Engineering Seminars, to be held at Cornell University. Participants attend general sessions and enroll in one of nine groups, which include engineering administration, systems simulation using digital computers, statistical decision-making, and statistical reliability analysis. Additional information can be obtained from J. W. Gavett, Seminars Coordinator, Dept. of Industrial and Engineering Administration, Upson Hall, Cornell University, Ithaca, N. Y.

June 13-23-

Experimental Techniques Course, offered at the Massachusetts Institute of Technology, is designed to provide the background for making and interpreting measurements in the general mechanical engineering field. Measurements include displacement, strain, force, torque, velocity, acceleration, flow, and temperature; methods include optical, mechanical, pneumatic, electric, and photographic. Further informa-

(Please turn to Page 50)



Dynapar is the electronic subsidiary of The Louis Allis Co. We make a full line of transistorized digital devices for high-speed counting, measuring, and control. Information on any of these products can be obtained from your local Louis Allis District Office — which is listed in The Yellow Pages under "Electric Motors."



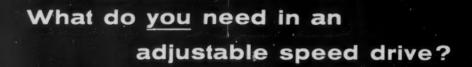
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Process



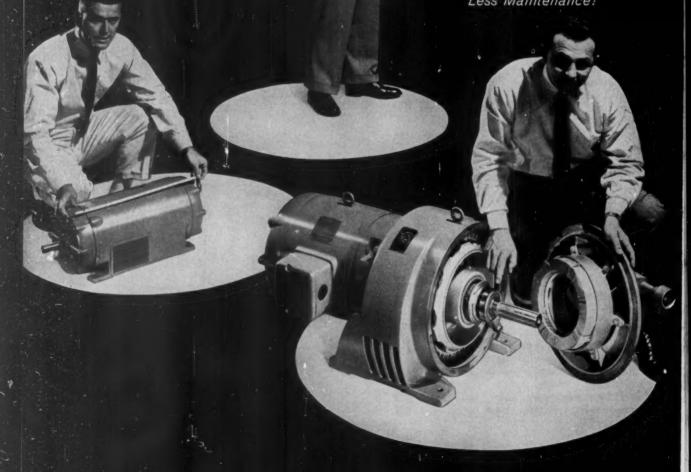
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71/2-hp Ajusto-Spede Drive



Common motor-drive housing for units up to $7\frac{1}{2}$ hp saves space — can be foot or flange mounted. Larger sizes up to 100 hp with individual motor and drive housings mounted integrally.

NEW design news from Louis Allis

...The Louis Allis AJUSTO-SPEDE® drive Is more compact, precise, and trouble-free

Here's an adjustable speed drive that allows truly precise machine operation. Speed regulation is automatic and stepless — results in faster, more efficient production at lower cost, with less waste, and minimum wear on equipment.

These and other benefits are yours when you use the improved Louis Allis Ajusto-Spede drive. For example, it can be set before or during operation to deliver any desired speed within its range. Its exclusive tachometer feedback circuit monitors the output speed and automatically corrects speed and holds it regardless of load changes,

This improved drive requires minimum maintenance. Its stationary field has no brushes, commutators, or slip rings to cause trouble. The source of power is an equally trouble-free standard a-c squirrel cage motor. The cast-iron housing keeps out dirt, chips, and moisture — resists corrosion.

The compact Ajusto-Spede also saves space. Integrally-mounted motor and drive simplify handling — can be easily adapted for installation on new or existing machines. Controls can be mounted at the machine or any other convenient position.

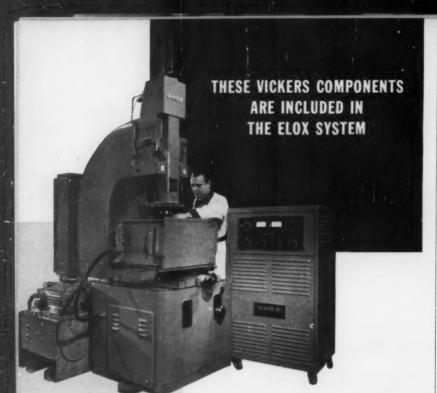
The Louis Allis Ajusto-Spede drive is the practical solution to almost every application that requires dependable, easily controlled adjustable speed. It is the answer to precise operating speeds for machine tools, process machinery, test equipment, windups, conveyors, printing presses, and other equipment. Contact your Louis Allis District Office for information and application help. Or write for bulletins 2750 and 2800 — The Louis Allis Co., 459 East Stewart Street, Milwaukee 1, Wisconsin.

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MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS



HYDRAULIC CYLINDERS — Low frictional drag and dependable operation of the 3-inch bore, 12-inch stroke cylinders makes them ideal for the Elox machine shown. Vickers builds a complete line of cylinders and offers a wide choice of mounting options, rod end threads, wrench flats, port positions and connections. Standard bore sizes range from 1½" to 8" with either standard or heavy duty rods; special designs can be provided to suit every application. For more details ask for Bulletin 60-68.

SERVO VALVES—Extremely critical requirements for low deadband and high response for instantaneous reversals to clear the electrode dictated the selection of a Vickers servo valve for the Elox spark discharge machine. Three series of Vickers servo valves are available to meet every type of industrial application: a single stage valve rated at 0-3 gpm and two series of 2-stage servo valves for flows of 0-17 gpm and 0-37 gpm. For more details ask for Bulletins 59-74, 61-79.

POWER PACKAGE—The standard Vickers T-10 power package supplies the steady pressure required for optimum operation of the Elox electrical discharge machine. A vane pump and relief valve matched to the system plus the basic tank unit constitute the power package. Vickers builds the most complete range of power packages available anywhere—all components "matched" in output to insure optimum performance and reliability. For more data on how these power packages can simplify your design and procurement problems, contact your Vickers Application Engineer.

Don't Miss Booth 549
Design Engineering Show
Detroit, May 22-25



VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1430 • Detroit 32, Michigan

ENGINEERING NEWS

(Continued from Page 47)

tion can be obtained from Director of the Summer Session, M.I.T., Cambridge 39, Mass.

Iune 19-23-

Scientific and Engineering Reports program, to be held at Massachusetts Institute of Technology, is for scientists, engineers, technical supervisors, and technical writers. The program will include guest lecturers from industry, discussions, and writing practice. Additional information is available from Director of the Summer Session, M.I.T., Cambridge 39, Mass.

Iune 19-23-

Technical Writing course, offered at the University of Michigan, will stress presentation, efficient language, and structure. Further information can be obtained from R. E. Carroll, Engineering Summer Conferences, 126A West Engineering Bldg., The University of Michigan, Ann Arbor, Mich.

Iune 19-30-

Human Engineering Concepts and Theory course to be given at the University of Michigan, will cover current trends, selected new developments in human-factors research, and applications. Additional information is available from R. E. Carroll, Engineering Summer Conferences, 126A West Engineering Bldg., The University of Michigan, Ann Arbor, Mich.



"The two schools of thought on this problem seem to be yours and M.I.T.'s."



ROBERT WEBB. RESEARCH DIRECTOR. ELOX CORPORATION SAYS:

"Jointly developed hydraulic system provides fast response needed for spark machining..."

"When people have a problem that can be solved with three-dimensional electric discharge machining, they come to Elox for our special skills and knowledge. Similarly, we insure that our machines offer the last word in performance by working as a team with components and systems manufacturers.

"To produce cavity dies like the one shown above, we designed and built a machine with a precision table and a vertical slide accuracy that we can guarantee within .0005" to 12 inches. We were able to develop a hydraulic circuit for the vertical slide and get a faster response than with any other method because Vickers engineers understood our problems thoroughly and cooperated fully in effecting their solution.

"Speed of response is half the story; the other is precise maintenance of the spark gap without 'hunting'—enabling the spark machining operation to be completed in the shortest possible cycle. Our hydraulic package meets all the foregoing requirements because the indi-

vidual units are matched to each other and to the machine itself."

The Elox experience is typical of Vickers assistance to machinery builders and/or users in providing outstanding hydraulic equipment or systems to insure peak performance. Specialists working with the broadest line of top quality hydraulic components available anywhere give you a system ideally suited to your specific needs. See facing page for more details about the hydraulic components used by Elox and the entire Vickers line.



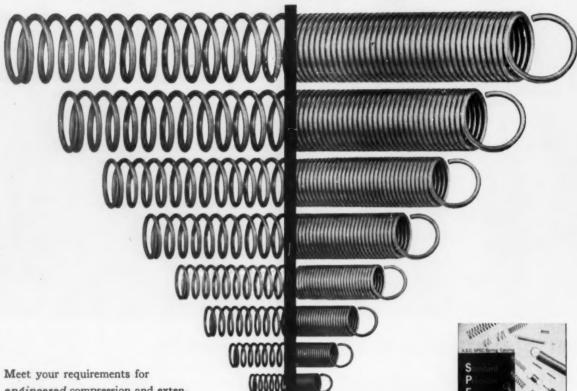
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Reuland's 15 year old service policy takes the word of any motor service shop of your choice.



Whether you're an O.E.M. or a User, when you buy REULAND electric motors you can make your decision with confidence. One very important reason, of course, is that every motor is backed by Reuland's 15 year old "Honor System Motor Service Policy"...still the only one in the industry!

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BOLT LENGTH vs. TORQUE RETENTION

Bolt length and bolt torque are important factors in maintaining flange loads on gasketed joints. New engineering studies show the extent of these effects to be greater than anticipated.

E. M. SMOLEY
Research Physicist
Armstrong Research and Development Center

Retention of bolt torque on gasketed joints is a function of several factors. Two important ones concern the bolt itself: its length and the amount of torque initially applied to it when the joint is tightened.

Recent tests were conducted at the Armstrong Research and Development Center to study (1) the relation of bolt length to torque retention; and (2) how torque retention is affected by variations in the amount of torque originally applied to the bolts.

In these tests, separate steel flanges were prepared to accommodate three different bolt lengths—½", 1", and 1½". (See Figure 1 for definition of bolt length.)

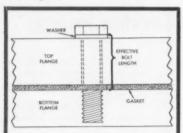


Figure 1. Here bolt length is defined as the distance from the underside of the bolt head to the face of the opposing flange—including the washer and the compressed gasket thickness.

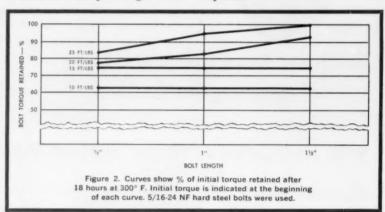
The flanges were gasketed with an Armstrong beater-saturated asbestos material—Accopac AN-890—in ½2" gauge. (Previous tests had indicated that this material possessed excellent torque retention characteristics.) The

only variables in the tests were bolt length and initial torque values.

After the bolts were torqued to specific loads at room temperature, the flanges were placed in an oven at 300° F. for a period of 18 hours. Then they were removed, and while the flanges were still hot, bolt torque was re-measured. The percentage of re-

short bolts . . . and the difference is greater as initial torque is increased.

These results are, of course, what was anticipated in quality. In quantity, however, the difference in torque retention resulting from variations in bolt length and initial torque values was significantly larger than had been expected.

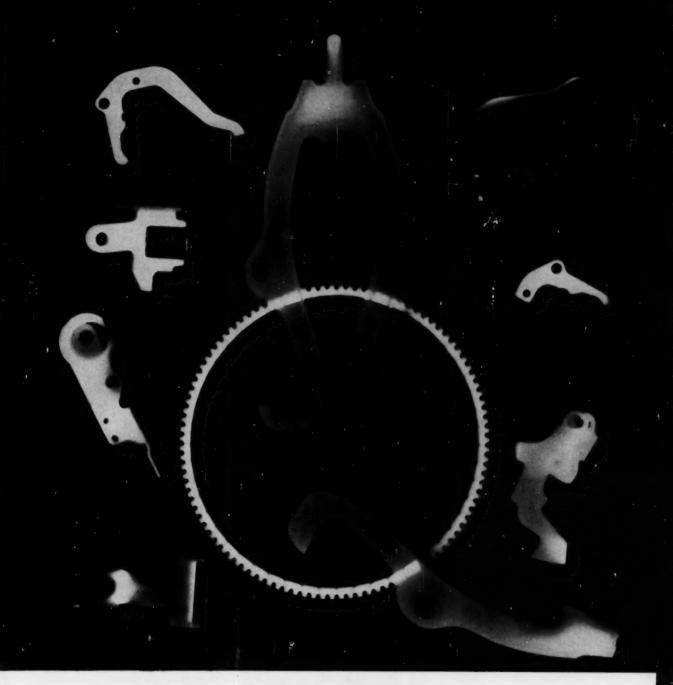


tained torque was calculated and charted as shown in Figure 2.

The chart shows clearly that low initial torque loads lose proportionately more torque than higher loads. At 10 ft-lbs of initial torque, for example, the average torque loss for the three bolt sizes was 37%. But at 25 ft-lbs of initial torque, the average loss was only about 8%.

The tests also indicate that longer bolts retain torque much better than Research on gasket performance is a continuing project at the Armstrong Research and Development Center. Our large library of data may already contain the answer to specific problems you may have on gasket design, performance, or selection. We will be glad to make suggestions if you will submit details to us. Address inquiries to Armstrong Cork Company, Industrial Division, 6505 Dean Street, Lancaster, Pennsylvania.

Armstrong GASKET MATERIALS



WHICH OF THESE STAMPINGS COSTS LESS WITH PRECISION STEEL?

All of them, as a matter of fact. The design requirements of the finished parts may—or may not—call for closer than standard tolerances. But in an intricate, high-speed operation, a variation of 0.003" could result in costly production problems—frequent delays, constant tool adjustment, a high percentage of rejects, etc.

With J&L strip steel cold rolled to precision tolerances, you can expect uniform, trouble-free stamping. The reduced production costs plus the increased product reliability will more than offset the slightly higher initial cost of precision steel.



The key to J&L's superiority in strip steel processing is its ability to produce to standards more exact and precise than those in general use.

J&L's combination of specialized equipment and techniques, plus experience, are available to solve your stamping problems. For information, call your J&L Stainless and Strip Division representative or write to Dept. 1359.



LOW CARBON . HIGH CARBON . ALLOY . STAINLESS TEMPERED SPRING STEEL . ZINC AND COPPER COATED

Jones & Laughlin Steel Corporation . STAINLESS and STRIP DIVISION . Youngstown 1, Ohio

Circle 235 on Page 19

Designers think of R/M first for asbestos, rubber,



Solves major operating problems for tire press manufacturer with new Teflon*-impregnated molded asbestos piston cups

New molded asbestos piston cups impregnated with Teflon, developed by Raybestos-Manhattan, Inc., have enabled National Rubber Machinery Company, Akron, Ohio, to improve the economy and efficiency of its Autoform Slideback Tire Press while realizing substantial savings. The new seal has not only reduced air loss to a minimum, but eliminated a lubrication system, cut maintenance, and increased machine operating life.

Before adopting R/M cups, NRM used metal rings for the ram and cylinder

assembly. These did not provide the seal required, permitted a 5 to 10% air loss, caused excessive wear on moving parts, and required lubricants which were entrained, seeped into the molds, and camaged the tire rubber.

In considering a suitable replacement for the metal rings, NRM tested various synthetic rubber and leather cups. All deteriorated rapidly in temperatures up to 380°F. Then R/M was consulted. Preliminary investigation indicated asbestoswith a Teflon filler as a potentially good combination for this application. Nearly a year of research, testing and engineering collaboration followed. Samples were developed and tested in the field under actual operating conditions. Only when all results were in—after two years—did NRM adopt R/M cups for use in all its presses.

R/M's experience in the manufacture of packings, gasket materials, and specialty products to meet the exacting and varied requirements of industry is at your disposal—whatever your need call on R/M.

The application of R/M piston cups provided two important benefits. It eliminated oil in the curing room, preventing damage to the tire rubber. It reduced air loss with properly fitted and installed cups.

Registered trademark for Du
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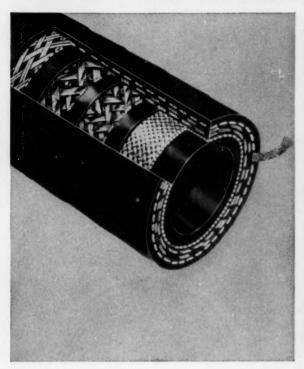


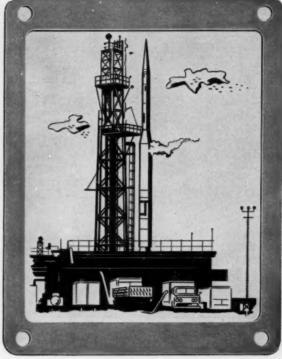
PACKINGS



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sintered metal, and engineered plastic products





Non-burst Rubber Steam Hose Strength of steel, heat resistance of asbestos, flexibility of rubber

For saturated steam pressures to 200 lbs., 388°F. Strength and durability are employed throughout the construction of Super-Master BW Steam Hose, illustrated above. Braids of high-tensile, non-corrosive steel wire are applied at a controlled angle over an asbestos-covered steam-resistant rubber tube for greatest strength with minimum elongation and contraction, and provide positive protection against bursting. Special Butyl rubber cover resists heat and weather, has static dissipating wire. The safest high-pressure steam hose made. Write for Bulletin M630.

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Most advanced gasket material yet for missile fuel systems

R/M F!.UOROBESTOS*—an asbestos felt impregnated with "Teflon," is fast becoming the accepted gasket material for missile fuel systems.

Approved by leading missile manufacturers for its compatibility with LOX and other exotic fuels, this new material combines "Teflon" and Pyrotex,® a carded asbestos felt based on extra-long spinning grade fiber.

In airborne and ground support applications, gaskets of Fluorobestos offer weight savings, high resistance to acids and solvents, and less deformation under load (as little as 0.1% under pressures of 2000 psi at temperatures to 500°F).

Fluorobestos is available in standard sheets of 40 x 40 in., in thicknesses from .015 to .125 in. Write for complete information and test samples.

*Registered trademark for R/M reinforced asbestos Teflon sheet.



For a copy of this booklet, full of information on R/M's complete line of "Teflon" Products, write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

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Here are tips to help you achieve packing-fluid compatibility!

The efficiency, safety and ultimate cost of a hydraulic system is largely dependent on the compatibility of its packings and fluid medium . . . how well they do or do not work together.

Mineral Oils

The above is frequently overlooked when a plant switches from one type of fluid to another. Take mineral oils, for example. Three general types are used in hydraulics, and are classified according to their aniline points: high, medium and low.

If, through error, a high aniline oil is used where low aniline oils are specified, rubber seals in the system would shrink and harden. Conversely, "high aniline" rubber seals will swell and soften in low aniline hydraulic oils. Leakage or equipment failure is the result.

To complicate the picture further, mineral oils made to the same specification by different oil manufacturers, using different crudes, will vary in aniline point to the degree that they may cause synthetic rubber seals to either shrink or swell.

Even among the various types of synthetic rubber used for hydraulic seals, the reactions to mineral oils vary. Buna S and Butyl seals, for example, will disintegrate in mineral oil while Buna N, Neoprene, Viton and Thiokol polymers work very well.

Fire-Resistant Fluids

In many hydraulic systems, mineral oils are being replaced by modern, synthetic fluids which eliminate fire hazards without affecting hydraulic efficiency.

Three types of fire-resistant fluids are in wide usage and each type requires a *compatible* packing.

The three basic types of synthetic fluids with recommended and maximum recommended operating temperatures are shown in the box.

Туре	Recommended Temperature	Maximum Recommended Temperature		
Phosphate Ester	+130°F.	+180°F.		
Water-Glycol	120°	150°		
Emulsion water-oil	120°	150°		

Phosphate Ester fluids and mineral oils have a directly opposite effect on the same rubber seals. Butyl packings which fail miserably in mineral oils, work beautifully with straight Phosphate Ester while Buna N, which works well in mineral oils, is unsuitable for Phosphate Ester. For this reason, changing a system from mineral oil to Phosphate Ester requires a complete and careful flushing and cleaning as well as a switch in packing materials, if elastomer packings are used.

For use with these fluids, homogeneous packings should be of Butyl, fabricated packings of Butyl and duck or asbestos and leather packings should be either Wax or Thiokol impregnated.

Water-Glycol fluids are generally compatible with both Buna N and Butyl seals, and with duck or asbestos. However, they do attack leather fibers. Water-Glycols have a pH of 8.5 to 10.5 and leather fibers start to disintegrate at a pH over 8.0

Because of this pH condition, leather packings are not recommended for use with Water-Glycols. Homogeneous packings should be of Buna N and fabricated packings of either asbestos or duck and Buna N.

Emulsion type fluids react much the same as mineral oils do with rubber and leather. In homogeneous and fabricated packings, use Buna N; in leather, use a filler of wax or Thiokol. Never use Emulsion fluids with Butyl.

A Simple Solution

As complex as the subject appears, packing-fluid compatibility in hydraulic systems can be determined with very little trouble. Houghton Packing-Fluid Compatibility Tables will instantly tell you which packings work best with the various types of fluids in general use.

Better yet, Houghton is in a unique position to give you completely unbiased answers to your hydraulic packing-fluid problems, for Houghton is the only manufacturer who offers you a complete line of both packings and fluids for industrial hydraulic systems.

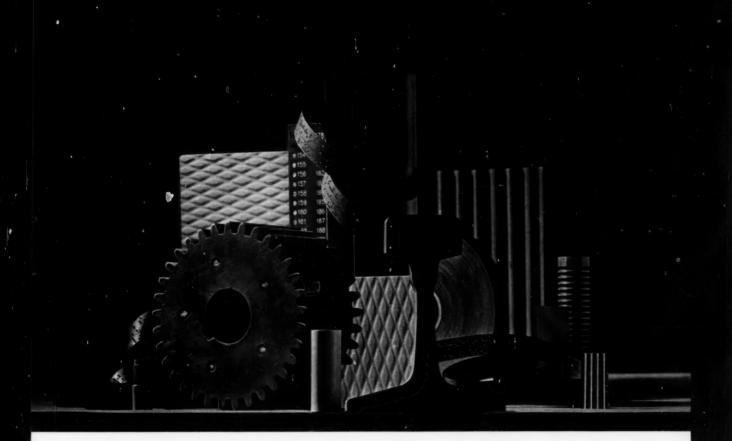
FREE! Packing-Fluid Compatibility Tables



For your copy of Houghton's Packing-Fluid Compatibility Table, or for help on any hydraulic packing or fluid problem, call your Houghton representative or write: E.F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Houghton

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THIS remarkable plastic may trigger a new (or cost-saving) design idea for you

National Vulcanized Fibre is unique. It's a tough, cellulosic plastic—not mere paper or fiberboard. Vulcanized Fibre possesses an unusual combination of mechanical, electrical and thermal properties. For example . . .

It weighs one-half as much as aluminum, yet is one of the strongest materials known per unit of weight. It's tough, durable and cushions the shock of repeated blows.

Vulcanized Fibre has superior arc-resistance. It comes in standard and special grades, including a fire-resistant grade called "Pyronil." It can be machined, formed or deep-drawn into intricate shapes, and can be combined with other materials . . . aluminum, rubber, "Mylar," copper, laminated plastic, plywood, to name a few.

You can polish it, paint it, lacquer it, emboss it. And regardless of the finish, it resists oils, gasoline, fungi, most solvents. Most surprising is its low cost.

Find out for yourself why National Vulcanized Fibre is "the plastic with a million uses." There's a free sample kit

waiting for you at a nearby NVF sales office. Check Sweet's Product Design File 2b/Na for the one nearest you. Or write directly to Dept. RP, Wilmington, Delaware.

116 Choices: One Source This is the latest count of the different plastics and grades NVF can offer in your search for the one best material. Add to this total the one special grade that can be developed from scratch to meet your particular need. This full range of materials is backed by complete engineering services . . . from application assistance up to and including the delivery of 100% usable, precision-fabricated parts . . . in any quantity, on time! Call the NVF Sales Office near you. It's a direct line to single-source help on your current materials problem.



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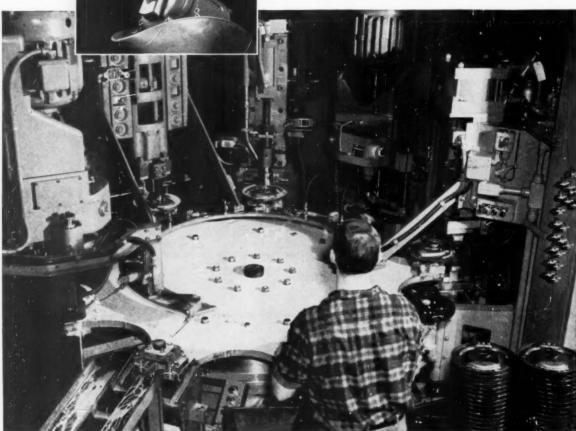








You're buying motors by the pound when price is the only consideration



Today's machine tools can't afford motors selected on the basis of price alone

Modern machine tools are designed to manufacture products of great precision at the lowest possible cost. But a machine tool is only as productive as the electric motors that drive it. Motors purchased on the basis of price alone often fail to give their users the greatest value in terms of useful service life.

The selection of the right motor to power your products requires not only specification of type, rating and operating characteristics, but consideration of such factors as uniform, troublefree performance, dependable long-life operation, the reputation of the manufacturer, and

his ability to provide immediate repair parts and service —when and where they're needed. Wagner® motors have earned their reputation for proven dependability in their specific applications.

Next time you buy motors, check beyond the purchase price. Make sure that you get all the performance you need—with motors that will do the job.

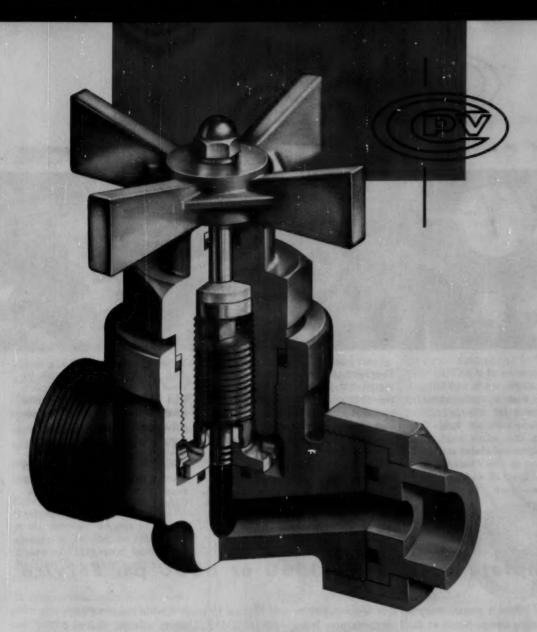
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WM61-4



THIS HIGH PRESSURE SYSTEM HAS MADE ALL OTHERS OBSOLETE!

And for good reason. Leakage can't be tolerated when line pressure soars to 6000 psi. The CPV O-SEAL SYSTEM not only satisfies this critical requirement, but provides a degree of design flexibility previously unavailable even for low pressure applications.

Leakproof connections are made — or broken—at will, and they remain leakproof regardless of vibration or line surge. CPV design employs O-rings as static seals that use line pressure to effect a perfect seal. In fact, the higher the pressure, the tighter the seal.

Valve packings, a constant source of maintenance, have been completely eliminated.

"Bubble-tight" valve shut-off is assured every time by combining a resilient nylon disc with a monel valve seat.

The reliability of CPV soft-seated valves and the effectiveness of O-ring sealing have been proven by certified government tests. In one of these, a CPV O-SEAL valve showed no sign of leakage at over 4000 psi after more than 4500 successive closures!

Also, the CPV O-SEAL SYSTEM is so flexible that you can assemble, remove, relocate or modify any section or the complete system without springing or cutting the lines.

Turn the page for more details on this proven breakthrough in high pressure system design...

See the CPV O-Seal System in action at the Design Engineering Show — Booth 805



O-SEAL SYSTEM for high pressures

"Bubble-Tight" at 6000 psi . . . Proved by the Nuclear Subs . . . Handtight Connections



Here's the business end of a CPV O-SEAL valve under test in a 6000 psi line. The thin film of soap solution covering the discharge port proves there isn't any leakage through the valve seat. Unique nylon disc and monel seat design combine to give "bubble-tight" valve shut-off of water, oil and any gas—even "hard to handle" helium.

Ever since the USS George Washington left the drawing boards, the O-SEAL SYSTEM has been specified for handling the critical high pressures on nuclear submarines. This, and a rapidly growing roster of industrial applications, underlines the basic soundness and proven reliability of this unique system for line pressures to 6000 psi.

Just tighten the union nut by hand and you have a connection that will be leakproof well above 6000 psi. Even after installation, valve can be repositioned or removed merely by loosening the union nuts. Same principle applies to unions, elbows, tees, and fittings. Unlimited flexibility is assured without sacrificing leaktight requirements.

A Complete System for 1500 or 6000 psi Service

CPV offers a complete system of O-Seal valves and fittings to meet a wide range of high pressure design needs at fluid temperatures from -20° to 275° F. Unions, elbows, tees and fittings in addition to globe, check and relief valves are available in sizes ranging from $\frac{1}{8}$ -inch to 2 inches. Two complete series—for working pressures to 1500 psi or to 6000 psi—provide unequalled design flexibility.

Details and specifications on the full line of CPV O-SEAL valves and fittings are given in 36-page Catalog 60-A. Clip the coupon below to your company letterhead and mail to CPV today for your copy.

Combination Pump Valve Company
846 Preston Street, Philadelphia 4, Pa.

Please send me Catalog 60-A on the CPV O-SEAL SYSTEM

Name

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FEAR



BRIEFINGS

ROLLER GUIDANCE-VITAL FACTOR IN BEARING LIFE

Roller guidance has been established by the Anti-Friction Bearing Manufacturers Association as a major rating factor for roller bearings. There is a direct relationship between this factor and the life and capacity of a cylindrical roller bearing under load.

Figure 1 illustrates the results of a loose fit between a roller and the guiding ribs of the raceway. Because of lack of guidance by the ribs, the roller is free to skew and skid under load. Such a condition invariably leads to early bearing failure.

To achieve close roller fit and proper roller guidance, Bower precision grinds each bearing race on specially designed centerless grinders. In this operation, Bower positions the integral raceway ribs from the theoretical centerline of the bearing. This method produces bearings with high dimensional accuracy and perfect symmetry.

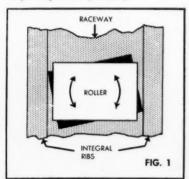
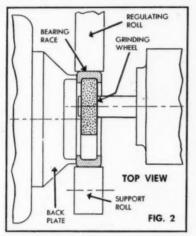


Fig. 1. Loose fit in raceway means poor roller guidance. Roller can skew and skid under load.

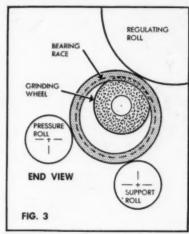
In addition, the close tolerances held in grinding the roller track and integral guiding ribs give Bower cylindrical roller bearings the ability to take thrust in any direction. A Bower cylindrical roller bearing has thrust capacity of



from 10-15% of its rated radial capacity!

Figures 2 and 3 diagram the centerless grinding method used to finish Bower raceways. Use of this technique assures not only optimum roller guidance and maximum bearing life, but also virtually eliminates bearing runout. BEARING SYMMETRY WHICH RESULTS FROM THIS TECHNIQUE PERMITS ACCURATE SHAFT LO-

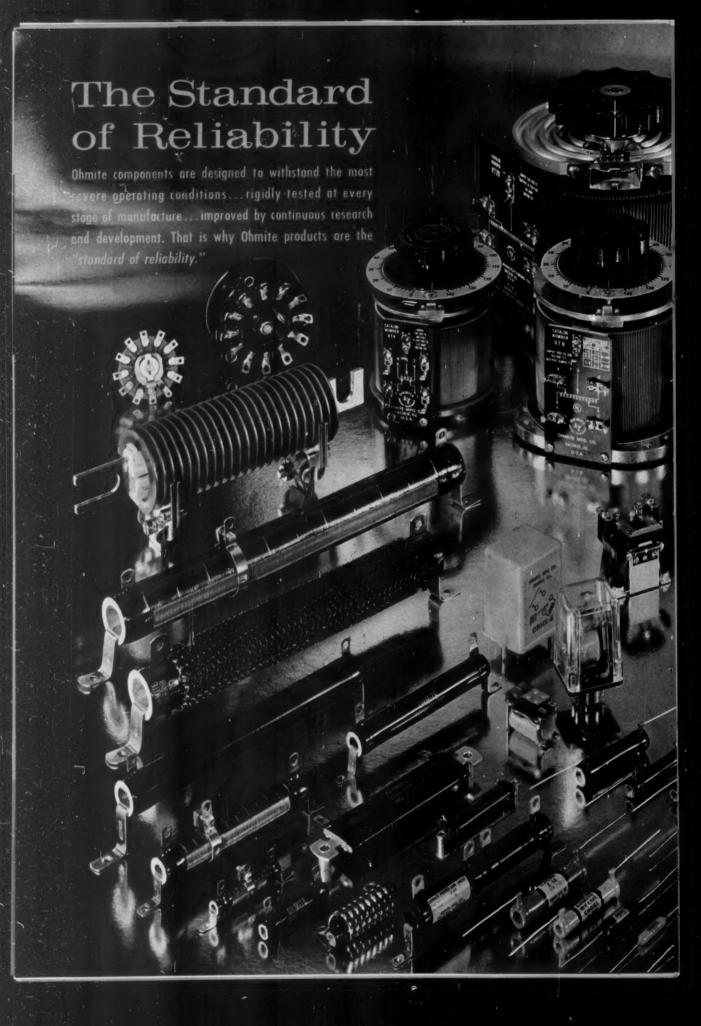
CATION REGARDLESS OF HOW THE OUTER RACE AND ROLLER ASSEMBLY ARE INSTALLED. IT COMPLETELY ELIMINATES THE POSSIBILITY OF IMPROPER INSTALLATION.

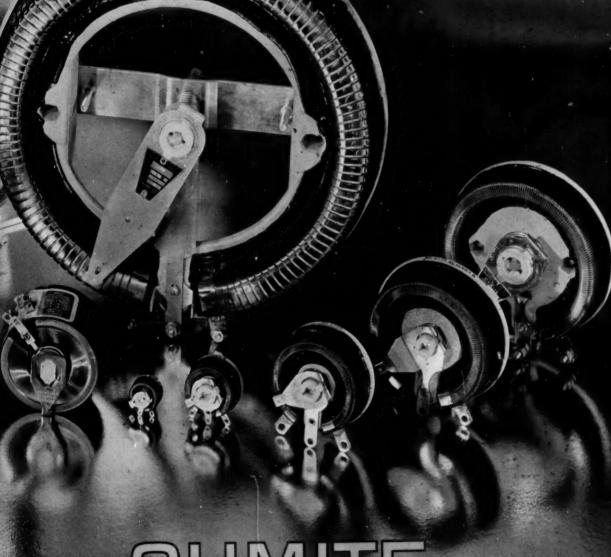


Whatever your bearing needs, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION - FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN



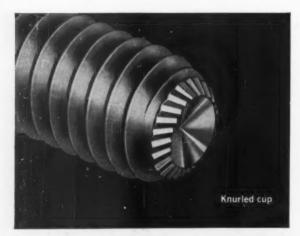


OHMITE

TRANSFORMERS - TANBALUM CAPACITORS - TAP SWITCHES

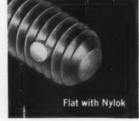
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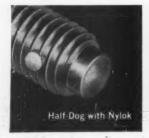
Fine points in the art of selecting set screws...by UNBRAKO













When holding power is paramount in your designs, you turn to set screws. But two questions may arise: What brand? And what point? UNBRAKO offers satisfactory answers to both . . . in a complete range of set screws for every application.

UNBRAKO with Knurled Cup Point.* Ideal where quick and permanent location of gears, collars and pulleys on shaft is called for, this set screw is at least *five times as vibration resistant* as its closest competitor.

UNRAKO with Plain Cup Point and Nylok.† Also self-locking, this set screw—owing to the resilient nylon pellet—locks securely in place whether seated or not. Use it against shafts too hard for the knurled cup point to bite into or where fine adjustments must be held.

UNBRAKO Cone, Half-Dog, Flat and Oval Points. There are instances when neither the knurled cup nor the plain cup with Nylok will fulfill the requirements of your design. Then you will need one of the following point types:

- Cone—for permanent location of parts; as a pivot in machine design (when point has hardness of at least RC 45); for making fine adjustments over a limited distance.
- Helf-Dog—for permanent location of parts; in place of dowel pins; against hardened members or on hollow tubing when Nylok insert is also used.
- Flot—for frequent resetting of one machine part in relation to another; as an adjusting screw for fine linear adjustments; where wall is thin; on top of plugs made of soft material.
- Oval—for frequent adjustment without excessive deformation of part against which it bears. Also for seating against angular surface.

To build in a guarantee of locking, you will want to specify the Nylok feature for all set screws except those with the knurled cup point,

UNBRAKO socket set screws are available in sizes #0 through 1 in. in alloy and #0 through ½ in. in stainless steels. Ask your UNBRAKO distributor for more details. For booklet on UNBRAKO High Torque Set Screws write to Standard Pressed Steel Co., INDUSTRIAL FASTENER DIVISION, SPS, JENKINTOWN 18, PENNSYLVANIA.

*Standard, at no extra cost

†T.M. Reg. U.S. Pat. Off., The Nylok Corporation



where reliability replaces probability



It's easier to strike a match on plate glass than on the smooth surface of a Hoover bearing raceway. A special process, developed and used only by Hoover, hones raceways until they are ultra smooth, superbly finished. With both inner and outer raceways Hoover Honed to microscopic perfection, Hoover ball bearings have a distinctive quality advantage.

Equally important as the Hoover Honed raceways

are carefully matched sets of Micro-Velvet balls which are accurate within millionths of an inch. These precision components work together in hushed quietness, an excellent indication of bearing quality and a characteristic of all Hoover bearings.

Outstanding quality-Hoover Quality-pays off in longer life, greater load capacity and superior bearing performance in a wide range of applications.

Hoover Honed and Micro-Velvet are Hoover Trademarks

BALL AND BEARING COMPANY

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hoover controls hoover quality from start to finish



Hoover's Cuyahoga Steel and Wire Division produces qual-ity chrome alloy steel wire from which balls are made.



Micro-Velvet balls are products of Hoover Ball Division plants in Middletown, Ohio, and Erwin, Tenness



Non-destructive electronic testing devices check bearing parts for tolerance, hardness and hidden flaws.

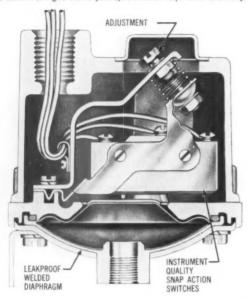


Hoover bearings in a wide range of types and sizes always measure up to high Hoover Quality standards.

BREAKTHROUGH IN PRESSURE SWITCH ACCURACY

at reduced prices

The high accuracy associated with instruments costing several hundred dollars is now obtainable with new Barksdale pressure switches at a retail cost of \$19.00 to \$30.00. Accuracy of $\pm 0.5\%$ is guaranteed and $\pm 0.2\%$ accuracy can be supplied when required. Substantial price reduction is accomplished by use of erector set design and a major investment in production tooling. A wide choice of "tailored to the job" features (see column at right) meets your specification requirements exactly.



THESE POINTS ARE IMPORTANT

WE BUILD IN

EXTREME ACCURACY and DEPENDABILITY

maintained during operating life due to direct acting design

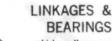
OPERATION IN ANY POSITION

which saves the installation costs encountered in mounting a switch that uses liquid switching elements

IMMUNITY TO VIBRATION

you can mount the switch directly on your vibrating or moving equipment.

WE DON'T USE



which, as they wear, make the setting of the pressure switch drift.

LIQUID SWITCHING ELEMENTS

which make the switch difficult to mount and very critical to vibration.

sensitive to vibration



Darkedale valves

5125 Alcoa Avenue, Los Angeles 58, California

New line of Barksdale pressure switches announced

Improved accuracy, reduced cost and higher proof pressures are advantages made possible by design innovations in the new Barksdale diaphragm pressure switches. Accuracy of $\pm 0.5\%$ as compared to the customary $\pm 1.0\%$ is guaranteed, and each unit is tested for repeat accuracy of set point and re-set point before shipment. Accuracies of $\pm 0.2\%$ are available on request.

Erector set design offers dual benefit

The basic unit of all Barksdale diaphragm pressure switches is a diaphragm surrounded by a heavy protective capsule to which components may be attached as required. Addition of a switch, switch bracket and adjusting bracket to the basic unit makes a stripped switch for use in a common cabinet with other electrical devices. (Original equipment manufacturers need not pay for a housing which is not needed.) Addition of a sealed housing to the stripped switch completes a weather- and vapor-tight switch unit. A standard housing with integral terminal block or an explosion proof housing with integral terminal block may be specified. Erector set construction allows a wide choice in specifications that approximates a custom made switch and permits use of cost-cutting mass production methods that are reflected in lower prices.

Proof pressures to 600 psi

In the low settings the new Barksdale pressure switches will actuate at 0.1" mercury with proof pressure to 10 psi. In higher ranges they will go up to 600 psi proof pressure at settings to 400 psi. This makes it possible to use inexpensive diaphragm pressure switches on installations that presently require higher priced bourdon tube switches.

Important additional advantages

Because the housings of Barksdale pressure switches are independent of the sensing and switching mechanisms changes in ambient temperature will not throw these switches out of adjustment.

The adjustment brackets are specially designed to protect switch terminals against shorting during adjustment.

Lead wires are held down by a tension clip. They cannot be pulled out accidently and thereby throw off the switch adinstruct.

Mounting brackets may be oriented in any of four directions.

Tamper proof adjustment covers have servicing instructions on the inside to allow for painting of the units.

Standard pressure connection is ½" n.p.t. female pipe fitting. One-half inch fittings suitable for mounting directly on ½" pipe can be supplied on request.

Standard housing has 1/2" nps conduit connections and a terminal block. The latter is accessible without removing the housing by lifting a cover plate.

Ask for new catalog and handbook

Complete details on Barksdale diaphragm, piston and bourdon tube pressure switches are included in a new catalog and handbook. This free book is a practical aid in planning the vital link between your electric and hydraulic circuits.

It contains a glossary of terms, a schematic demonstration of operating characteristics, and a suggested step-by-step procedure for simplifying pressure switch selection. In addition, the book gives a complete run-down on all the detail features leading to the unit that answers your specific control problems. Send for your copy now, or ask your Barks-dale representative.

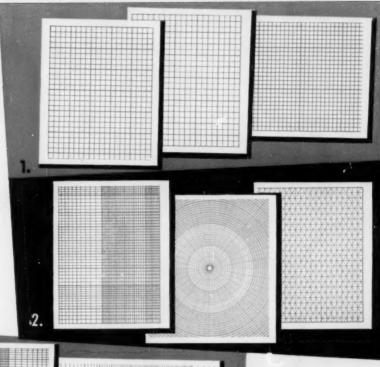


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May 11, 1961

Circle 248 on Page 19

69

the big news story for suppliers and

grommets O-rings linings seals tubing bushings diaphragms ball joints Few industrial parts now being molded, machined or cast of plastic, metal or rubber fall very far beyond the range of TEXIN'S enimpellers gineering capabilities. New markets include extruded tubing, hose, cable jacketing. Get the facts now on this important technological advance.

Tensile strengths of TEXIN elastomer test bars range from 4,000 to 8,000 psi, with elongation from 450 to 800 percent.

users of elasto-plastic components!



Now Permits Mass Production of Urethane Elastomer Parts by Low-Cost Injection and Transfer Molding or Extrusion

TEXIN, a newly-developed urethane elastomer "green stock" resin supplied in chopped particle form, is designed for those mass market industrial applications which require a highly-functional elasto-plastic material that can be simply processed with existing equipment by fast-cycle, low-cost methods.

TEXIN by-passes the costly, time-consuming liquid casting system formerly required in processing cured urethane elastomer items. Yet, it gives you the immediate market advantage of a thoroughly field-tested material, with properties identical to cast Multrathane® elastomers, while reducing part-forming time from hours to a matter of seconds.

TEXIN is specially formulated for heavy-duty ap-

plications which demand the unusual combination of wear resistance, hardness, elasticity, and high impact and mechanical strengths — particularly in original equipment components having difficult design features such as undercuts, slots, tapers, gear teeth, inserts and threads subject to high abrasive wear or oil immersion. Literally hundreds of these applications, many not adaptable to casting methods, are 'right' for molded urethane elastomer. TEXIN can bring them in.

The markets for urethane elastomer items are already well developed and waiting to hook into your production line. For full details and technical assistance, write immediately to Mobay Chemical Company, Code M C - 7, Pittsburgh 5, Pa.

Туре	Specific Gravity	Bulk Factor	Hardness		Tensile	Elongation	Tensile Modulus psi			Elongation	Tear
			Shore A	Shore D	Strength	at break	100%	200%	300%	Set	Strength
192 A Molding Grade	1.25	2.7	92-94	44–45	4400 psi	600%	1150	1550	2050	45%	300 lbs.
280 A Extrusion Grade	1.25	2.7	80	_	5500 psi	600%	650	900	1500	30%	_

Send for your copy of Texin Topics, an illustrated bulletin describing the latest application developments in the urethane elastomer field.



9TH NATIONAL PLASTICS
EXPOSITION

JUNE 5-9, 1961 COLISEUM, N.Y.C. sponsored by Society of The Plastics Industry, Inc.



Are your "dead storage" files more efficient than your active drafting files?

No doubt about it—it's important to keep correspondence carefully filed; but it is even more important to equip your drafting department with modern filing facilities that keep active and semi-active drawings readily accessible, fully protected—and in a minimum of space.





Your draftsmen, your productivity, deserve new <u>Hamilton</u> space-and-time-saving equipment — from Bruning

Inadequate or antiquated equipment in your drafting room can cost you more money than you imagine in lost time, errors, done-over work, and low morale. Hamilton equipment is engineered to fit your needs. It is designed to improve the practical, day-to-day creativity of your engineers or draftsmen. Its performance has been tested and proved in many thousands of installations. Our designers will gladly assist in the planning of your department. No obligation, of course.

HAMILTON UNIT SYSTEM FILES The Hamilton system offers maximum protection and capacity in minimum floor space. Each drawer of the patented shallow drawer units is equipped with a tracing lifting mechanism. Every tracing becomes a top sheet, instantly accessible. Unit sections can be assembled in a number of arrangements, stacked safely to any practical height. They stand up to hard usage, perform perfectly year after year.



Hamilton L-Contour Table Prestige-assured, individualized work area providing complete board adjustment plus extra storage and reference area.



Hamilton CL 100 Drafting Table Conserves dollars, yet rugged canted-leg design provides modern styling and convenience with long-term durability.



Hamilton Auto-Shift Table Built-in mechanism adjusts board to individual height and slope requirements, provides full accessibility, reduces errors.

Put draftsmen in a "position" to do better, faster work!

Bruning's all-new Neoglide drafters literally help draftsmen straighten up and do faster, better work.* They provide complete maneuverability on any board at any angle without adjustment! Reinforced U-beam construction assures rigidity, strength, and accuracy. Resistance-free movement of vertical beam and hidden counterweight provide fast "floating" action. Touch-control protractor head gives automatic, pinpoint angle selection.

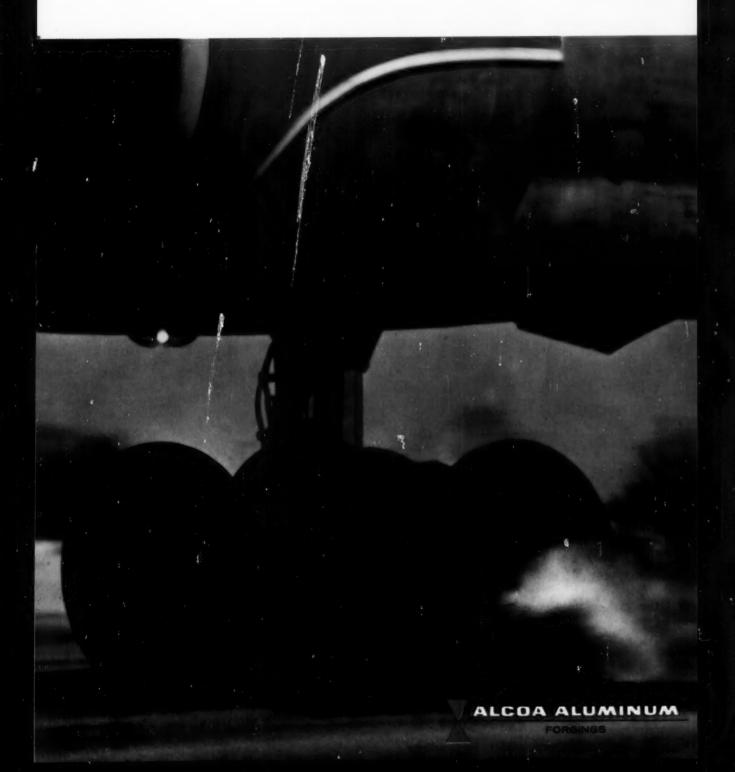
*Study of 300 draftsmen showed 35% savings in drawing time—1/5 the backaches—on vertical or near vertical boards.



BRUNING

CHARLES BRUNING CO., INC. 1800 CENTRAL RD., MT. PROSPECT, ILLINOIS

When 80-lb forgings take a 100-ton wallop...



When 80-lb forgings take a 100-ton wallop...that's Alcoa Total Ability at work!



Talk about impact resistance! When 200,000 lb of jet airliner kiss the runway on lightweight wheels forged by Alcoa, you know aluminum can absorb tremendous shock loads.

Alcoa® Aluminum Forgings are being designed as strong as steel forgings—and weigh dramatically less!

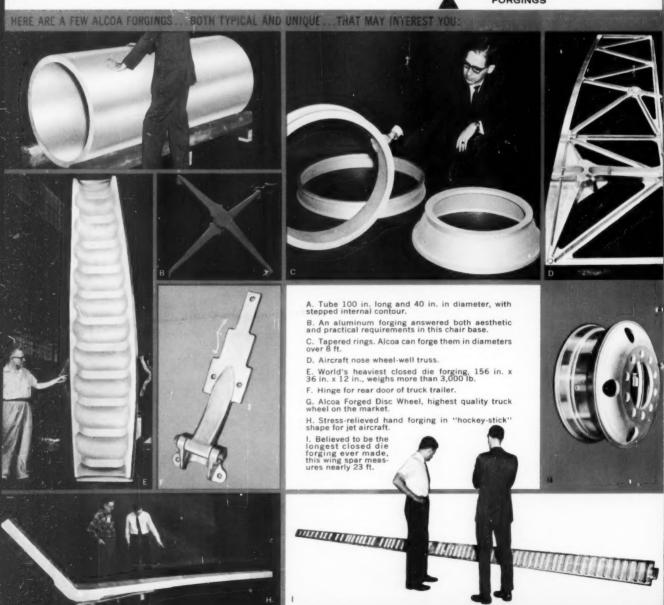
Aircraft wheels are a case in point. Higher landing and take-off speeds, heavier loads, tubeless tires, higher tire pressures—all demand the ultimate in wheel strength. Another consideration is the need for bigger brakes. Well-designed forgings provide more strength and maximum space for full-sized drums or discs. Alcoa's vast forging facilities have provided the aircraft industry with its biggest and smallest forged aluminum—and magnesium—wheels.

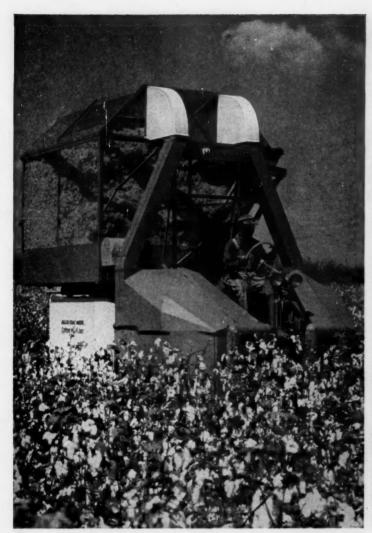
How Alcoa's Total Ability effects savings:

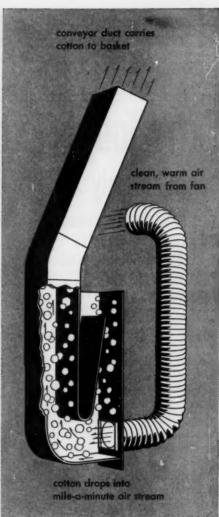
Alcoa runs the world's largest light-metals workshop. We can forge, cast, roll, draw, extrude, impact, machine, fasten, texture and color aluminum by every practical means.

With experience and ability in every facet of aluminum, we feel no compulsion to beat the drum for any particular method of fabrication. We'll work with you from the design stage to the finished product—make significant contributions all along the way and proposals that are biased only in the direction of lowering costs. Let us prove it. Simply get in touch with your nearest Alcoa sales office, or write: Aluminum Company of America, 856-E Alcoa Building, Pittsburgh 19, Pa.









Flexible Tubing helps carry cotton a-mile-a-minute through new Allis-Chalmers Picker...

Proof that today's designers can make Flexible Tubing do almost anything

In the newest Allis-Chalmers Cotton Picker, a jet air stream catches the cotton, and blows it—a-mile-a-minute—up conveyor ducts to the basket. Carrying this high-speed air stream from fan to picking units: Flexible Tubing's nonmetallic "Flexflyte."

Allis-Chalmers designers chose "Flexflyte" for two reasons: (1) it provides a fast, easy way to connect the fan outlet to the picking unit — a way that permits the unit to be raised and lowered on the job; (2) it makes extremely tight bends without collapsing.

If you work on any kind of original equipment where the handling of air, gases, liquids, or light solids is a design problem, there's a Flexible Tubing product just right for the job. Flexible Tubing is at work today in space age products, vacuum cleaners, diesel engines, tape recorders...literally hundreds of places. Call your nearest Flexible Tubing regional office today.



Flexible Tubing

CORPORATION

65 New Whitfield St., Guilford, Conn. Anaheim (Los Angeles) • Hillside (Chicago)

Atlanta — Cleveland — Dallas — Dayton — San Francisco — Wichita

Setko's 23 Years of Progressive Engineer ing Experience Keeps Screws Modern as Tomorrow's Products

Vol. 4. Issue No. 1



We Specialize in Solving Puzzling Screw Problems

Progress Edition

Extra Tough, Extra Clean, Extra Scale-Free

because only SETKO Screws are Isothermal Heat Treated

THIS HEAT TREATING PROCESS IMPARTS A DISTINCTIVE BLUE-BLACK COLOR WHILE PROVIDING DISTINCTIVE PERFORMANCE CHARACTERISTICS . . . YET. IT COSTS YOU NOTHING EXTRA.

Extensive use has proven that socket screw products treated by this process are tougher and cleaner. Threads, heads, points, shanks, etc. are scale-free. This means better fit, better performance. Also, Isothermal heat treated socket screw products prevent decarburization...and it costs you nothing extra. It's another Setko exclusive in the socket screw field.



Standard on most Setko socket screw products

Scale free

Isothermal heat treating has been adopted by Setko as a standard on most standard and special socket screw products including; hex socket, fluted socket, and slabbed head set screws as well as hex socket cap screws. (Stainless steel screws are generally not heat treated.) Unless you specify otherwise, screws that you order in these primary categories, regardless of points, or locking actions, will be isothermal heat treated. It costs you nothing more for this bonus value

Take the Setko "Look Test"

Compare the unplated finish of Setko socket

screws with other products using other methods. You'll see the cleaner, scale-free threads, heads and points that have made Setko socket screw products outstanding in their field. Write for test samples. Send us your specifications and requirements for advantageous quotations.

directly plated

Isothermal heat treating minimizes distortion

You get low cost, more dependable performance on the production line and in the field - Isothermal heat treated screws have a minimum of distortion. Far less than commonly used methods. Screws fit better, hold tighter. It's the same heat treating method used by manufacturers of precision products such as: razor blades, etc.

reanalyze your socket screw product requirements

As a part of the continuing Setko program of product re-evaluation, Setko engineers will work with you in determining the best combinations of devices for your specific requirements. All you have to do is send a sample of the assembly with your specifications and they will make recommendations and suggestions, promptly and without delay. Take advantage of this offer today, you may realize substantial savings in increased reliability, lower production costs, or faster, easier assembly methods. Address requests on your company letterhead.



28 Main Street, Bartlett, III. (Chicago Suburb)

SILICOLOGY Studies in Silicones HOW THESE TIME-TESTED MATERIALS CAN WORK FOR YOU

New Silicone Rubber Compounds Now Can Be Molded to Closest Tolerances

Looking for durable rubber compounds had already achieved a long list of "firsts' that offer precision molding, reliability, and flexibility over a wide temperature range-where other materials have failed?

Here is one example of how silicone rubber compounds came into existence to fill these requirements, through cooperation between Silicones Division engineers and their customers.

Sierra Engineering Company, Sierra Madre, Calif., had a new emergency oxygen mask under development for passengers on today's high-altitude, highspeed jet airliners. They needed a rubber material with these properties:

- 1. Resiliency to spring back to shape after folded storage.
- 2. Softness to conform to facial contours.
- 3. Extremely low oxygen permeability.
- 4. Good color dispersion.
- 5. Non-irritating, non-allergenic proper-
- 6. No smoke or fume problems during

COOPERATIVE ENGINEERING

The Union Carbide Silicones Man brought these and other requirements back to his team of associates in R&D.

Prior to this, the combined technical and research facilities of Union Carbide Corporation, with tremendous resources of chemical experience and knowledge,

in silicone rubber, including:

A controlled reactivity, vinyl-containing silicone rubber. A non-volatile catalyst system for one-step curing of thick sections. Electrically conductive silicone rubber. A rubber for electrical tapes, hot-air ducting, and other wrapped constructions. A compound to meet Naval cable specifications for atomic submarines. And the first and only silicone rubber compound qualified for automotive rear pinion seals.



FROM UNION CARBIDE-first commercial silicone compound for highaltitude emergency oxygen masks.



SIERRA ENGINEERING COMPANY of Sierra Madre, Calif., tests every silicone rubber mask it manufactures and maintains an accurate serial number check to be sure the quality is uniform at all times.

MEETING BASIC PRODUCTION PROBLEMS

For Sierra's oxygen masks, the principal properties needed had all been met before, but not in a single silicone rubber compound. Working closely with Sierra, engineers of the Silicones Division succeeded in formulating a compound that matched the needs and answered all basic production problems as well.

The new compound permits molding to extremely close tolerances. Its purity means freedom from smoke and fume problems during post-cure. It more than meets Sierra's strict quality controls, including complete performance test records on every mask produced. And the same compound is now also being used for Sierra's oxygen masks designed for military jet pilots and the crews of com-mercial planes.

MAIL COUPON FOR DATA

If your designing calls for rubber with advantages such as low temperature flexibility, thermal and oxidation stability at very high temperatures, low compression set, weather, ozone, oil resistance, electrical resistance or conductivity, your Silicones Man has them at his finger tips. The coupon below will bring your problems to his immediate attention.



SILICONES

UNION CARBIDE is a registered trade mark of Union Carbide Corporation.

Silicones Divisio Union Carbide C Dept. BL-9101 270 Park Avenue	**
In Canada: Unio Bakelite Division	on Carbide Canada Ltd., n, Toronto 12.
Please send me d	lata on
NAME	
TITLE	
COMPANY	
Address	
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"LFN" SERIES

"Dyflon"

Self-Aligning and Self-Lubricating
SPHERICAL BEARINGS

Combine "Monoball"®
Engineering Advantages

Life-Time Lubrication

ROD END INTERNAL THREAD TYPE "DREF" SERIES

Design engineers in many industries are specifying new "DYFLON"® SELF-ALIGNING and SELF-LUBRICATING SPHERICAL BEARINGS for these 5 major reasons:

1. LOWER COEFFICIENT OF FRICTION

...ideal where lubrication is impossible or undesirable.

2. WITHSTAND EXTREME VIBRATION...perfect performance under shock load conditions.

3. WILL NOT "COLD-FLOW"... even under extreme load conditions.

4. IMPERVIOUS TO KNOWN CHEMICAL SOLVENTS ... eliminates corrosion problems.

5. FAIL SAFE...due to "Monoball" @ design.

In addition, due to their two-piece "MONOBALL"® design and plastic alloy insert, "Dyflon"® bearings have a long cycle life. Alignment and installation problems are minimized. Oil-free for life means lowest possible maintenance costs.

Available in a variety of plain or rod end types. Bore sizes to 3.000". Materials include stainless steel, plastic alloys and chrome alloy steels. Ultimate static loads to 500,000 lbs.







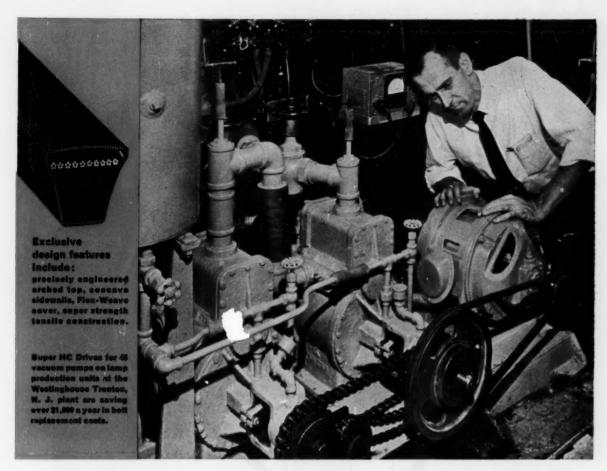
Engineered to the same high standards as Southwest's popular "MONOBALL"® Self-Aligning Bearings.

SOUTHWEST "DYFLON"® "Monoball"® bearings can solve your difficult alignment and installation problems. Request Engineering manual No. 551.



SOUTHWEST PRODUCTS CO.

1705 SO. MOUNTAIN AVE. . MONROVIA, CALIF. . PHONE: MURRAY 1-9616



Westinghouse converts drives on 45 machines to new Gates Super HC High Capacity V-Belts

When drive space is limited, a driver sheave too small in diameter is sometimes used—though not recommended. Constant flexing over a small sheave is severe punishment for V-belts. Because of this, conventional V-belts lasted 4 months or less on the vacuum pumps on lamp production units at the Westinghouse Lamp Division plant in Trenton, N.J.

Now, with space-saving Gates Super HC High Capacity V-Belt Drives on all 45 machines, all belts are still running strong after more than 1½ years...a saving of over \$1,000 in belt replacement costs plus even greater savings through reduced down-time.

The Gates Super High Capacity V-Belt is a new concept in V-belt design.

It is industry's first and most advanced high capacity V-belt. Because of exclusive design

features, Gates Super High Capacity V-Belts transmit up to 3 times more horsepower than conventional V-belts in the same space. Or the same power can be handled with fewer belts and smaller sheaves in less space.

As a result, Gates Super HC Drives save up to 50% in drive space . . . cut your drive costs as much as 20% . . . reduce drive weight 20% and more . . . and make possible further savings in material costs.

Your local Gates Field Engineer is an experienced, fully-qualified drive design expert. Contact him for Super HC design information and for design help.

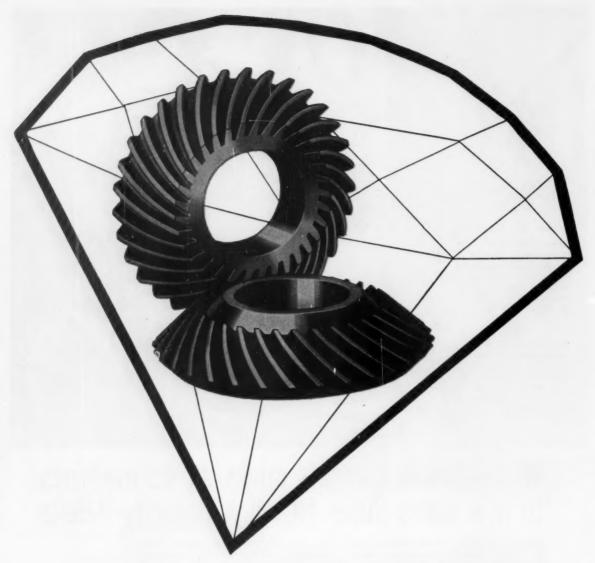
Gates Super HC Drive saves space, weight and money



Building the future on 50 years of progress

The Gates Rubber Company, Denver, Colorado

Gates Super HC V-Belt Drives



Flawless in every brilliant facet...

CINCINNATI

CUSTOM GEARS AND GEAR BOXES

achieve uniformly top quality in making your gearing designs precisely to your specifications.

Ask for this brochure—CINCINNATI custom gears are made in all types to 72" diameter cut teeth, 39" shaved teeth, 25" ground teeth.

better still . . . Send us your prints for quotation

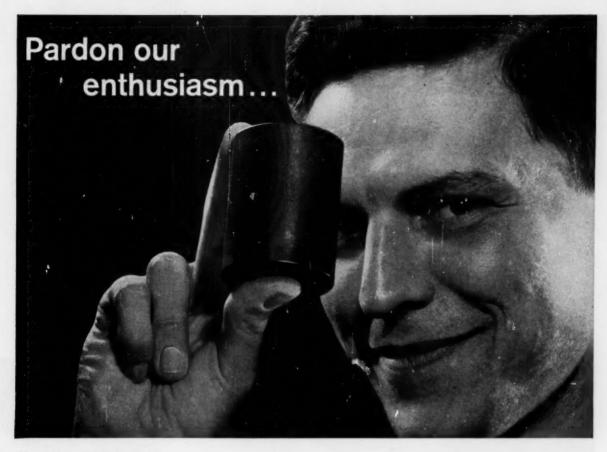




THE CINCINNATI GEAR CO.

Cincinnati 27, Ohio

Custom Gear Makers Since 1907 GEARS, good gears only



Here it is. HI WEAR 64.

A brand new tool steel with wear resistance well above high carbon, high chrome die steels. A deep hardening steel with low hardening temperature . . . good dimensional stability. Maybe it will solve a design problem you're working on right now. Maybe not.

But some day next week . . . next month . . . next year . . . you're going to balance a brilliant design idea against available materials to give it reality.

Then you'll remember Carpenter's HI WEAR 64.

Then you'll be glad you used this coupon today.

Carpenter stee!

you can do it consistently better with Carpenter Tool and Die Steels

The Carpenter Steel Company
Main Office and Mills, Reading, Pa.
Export Dept., Port Washington, N. Y.—"CARSTEELCO"
Alloy Tube Division, Union, N. J.
Webb Wire Division, New Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.



	rn, Manager, Tool Steel Sales npany, Dept. 120, Reading, Pa.
Send me HI WEAR 6	D. C.
I'd like a sample of HI	WEAR 64 for testing
Name	
Title	
Company	
Street	
-	Zone State

MCGILL CAMROL BEARINGS



SIMPLIFY DESIGN and ASSEMBLY

Stock sizes eliminate the cost of procuring and assembling improvised unit components

You can simplify design and cut cost with CAMROL precision anti-friction cam followers—built for the job. Complete units, with established performance ratings are available from stock in standard roller diameters from ½" to 4". Capacities to 20,480 lbs. at 100 R.P.M.

Precision anti-friction bearing accuracy

Precision construction, including concentricity of stud to outer race op, provides accurate alignment of machine members.

High load capacity in limited space

A full complement of race width rollers provides maximum capacity and ability to withstand heavy intermittent shock loading. The extra heavy outer ring and specially heat treated stud add durability and insures dependability of machine operation. Bolt mounted ball bearings crack under equivalent loads and plain bearings require constant oil lubrication.

Integral seals retain lubrication
—keep dirt out

SCF Sealed CAMROL bearings are interchangeable dimensionally with standard CAMROL bearings. They are pre-lubricated and have a ferrous oxide finish to resist corrosion. Effective sealing against contamination reduces machine maintenance.

Camrol CYR series



In the CYR Series, an inner race replaces the stud for yoke or shaft mounting. Standard and sealed CYR bearings are available in the same stock sizes as CF and SCF Series.

SEND FOR McGILL BEARING CATALOG NO. 52-A. for complete data on McGill CAMROL, GUIDEROL, MULTIROL and CAGEROL bearings.





SCHIELD BANTAM UTILIZES OF BEARING ADVAN-TAGES IN VARIETY OF APPLICATIONS.

The Schield Bantam Company has applied CF bearings in internal clutch band operating arms, turn controls, swing and travel shaft clutch cones, engagement controls and speed shift collars. The photo above shows how CF-1 bearings are applied to Drum Clutches in Schield Bantam Series 350 cranes and shovels.

This company replaced bronze collars and yokes and reports cost savings through the use of CAMROL bearings. In addition they have increased capacity and have experienced improvement in length of life and maintenance factors. This has added to the over-all efficiency and dependability in heavy equipment where "down-time" is extremely expensive.

ACRO WELDER REDUCES PRODUCTION COSTS, IMPROVES ACCURACY WITH SCF BEARINGS

SEALED CAMROL bearings are used to accurately locate and guide the welding ram in spot welders made by ACRO

WELDER MFG. CO. The user reports that the use of 12 prelubricated CAMROL bearings per machine has saved hours of machining labor formerly needed to provide grease passages for unsealed bear-

ings. Lower production costs, greater accuracy and high load capacity attained with these Mc-GILL bearings help to assure the best product performance at lowest cost.



insure precision performance in cam follower, track and guide roller applications



BUHR MACHINE TOOL CUTS FRICTION TO REDUCE HORSEPOWER WITH SEALED CAMPOL BEARINGS

Production parts are drilled, milled, bored and tapped in automated systems engineered and built by the BUHR MACHINE TOOL COMPANY. The moving fixtures which hold parts being machined are guided and carried on McGill sealed CAMROL bearings as shown in the close-up above. By reducing starting and running friction to an absolute minimum, the CAMROL bearings have made horsepower requirement reductions possible in these systems. Ample load capacity, high resistance to shock loads and integral seals which retain lubricant and keep out contamination have held maintenance down. 8 SCF-3 CAMROL bearings guide and support each fixture.





J. I. CASE USES SCF AND SCYR CAMROL BEAR-INGS IN HAY BALER

The bale compressing plunger of the J. I. Case Model 177 Heavy Duty Hay Baler rolls on CF-2¾-S CAMROL Bearings and CYR-1¾-S Bearings guide the plunger.

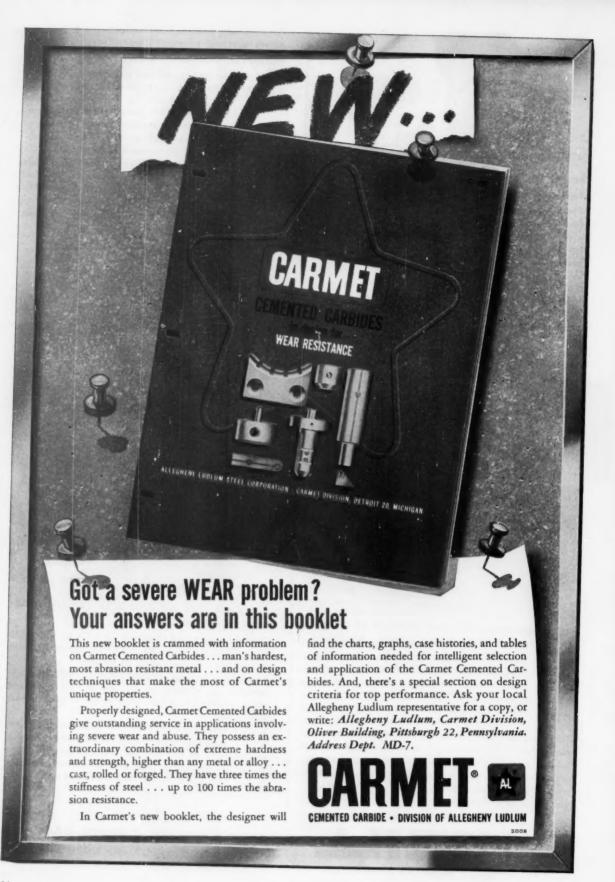
Anti-friction bearing dependability and trouble-free performance are essential in this type of field equipment where bearing failure may result in loss of valuable harvesting time.

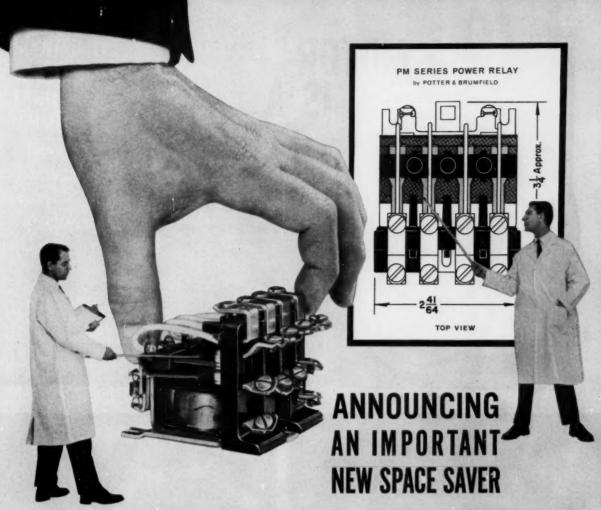
Integral bearing seals in these CAMROL bearings, keep relubrication requirements low and protect internal bearing components from field dirt, dust and moisture.

In addition to accurate, dependable action with minimum friction, high quality McGill CAMROL bearings offer savings on production and assembly.

MULTIROL-GUIDEROL-CAMROL-CAGEROL

McGILL MANUFACTURING CO., INC., Bearing Division 200 N. Lafayette Street, Valparaiso, Indiana





P&B compact 4PDT power relay switches one H.P. per moveable arm

Save panel space! This new 4-pole relay is only 3/16" wider than our PR Series, America's most popular 2-pole power relay! Yet, it is engineered for reliable heavy-duty switching . . . and you can confidently expect 10 million mechanical operations.

PM Series relays are rated at 16 amperes (or 1 H.P.) at 115 volts, 50/60 cycles resistive... and special relays can be supplied for loads up to 25 amperes, at 220 volts, 50/60 cycles resistive. Heavy screw terminals are arranged for fast, easy hook up. An adapter plate is available for mounting PM relays in the same location used for 2-pole relays.

For full information, write today or call your nearest P&B representative.



A whole family of power relays for a wide range of applications carry the P&B symbol of quality. Call P&B first for all your power relay requirements.

PM ENGINEERING DATA

GENERAL:

Description: Heavy-duty AC power relay.

Insulating Material: Molded phenolic.

Insulation Resistance: 100 megohms minimum.

Mechanical Life: 10 million operations minimum.

Contact Life: 100,000 operations minimum at rated load.

Breakdown Voltage: 2,000 volts res minimum between all elements and ground.

Ambient Temperature: -55°C to +55°C.

Weight: Approximately 14 azs.

Pull-In: 78% of nominal voltage.

Terminals: Heavy-duty screw type with No. 8-32 BH screw.

CONTACTS:

Arrangements: 4PDT or 4PST—normally open.

Material: 1/4" dia. silver-cadmium-oxide.

Rating: 16 amps @ 115 volts, 50/60 cps resistive. 8 amps @ 220 volts, 50/60 cps resistive.

1 H.P. per moveable, 115 or 220 volts AC single phase.

25 amps @ 220 volts, 50/60 cps resistive available on special order.

COILS:

Voltage: 6 to 230 volts AC 50/60 cycles.

Power: 14 volt-amps average at nominal voltage.

Duty: Continuous.

PAB STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONICS PARTS DISTRIBUTORS



DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY

PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

A MOTOR IS A SERIES OF CIRCLES BRACKET-TO-FRAME RABBET

BRACKET-TO-FRAME RABBET
STATOR FRAME I.D.
STATOR CORE DIA.
AIR GAP
ROTOR DIA.
BEARING O.D.
JOURNAL DIA.

All must be ACCURATELY CONCENTRIC if the motor is to run smoothly, quietly, trouble-free



CONCENTRICITY of Elliott C-W Motors begins with the bracket-to-frame fit, the reference for all subsequent "circles." Bearing bore and shaft bore are precisely centered within this accurate diameter.



TOLERANCE of 0.0007 in. for the bearing bore is checked by an air gage after finishing in a precision lathe. Master jig assures accurate positioning of bearing, essential to uniform air gap.

Elliott Crocker-Wheeler integral-hp a-c and d-c motors—from smallest to largest—are offered in all conventional enclosures and modifications; with insulation to suit the application, including [PASSA] epoxy insulation, for use where conditions are most severe.

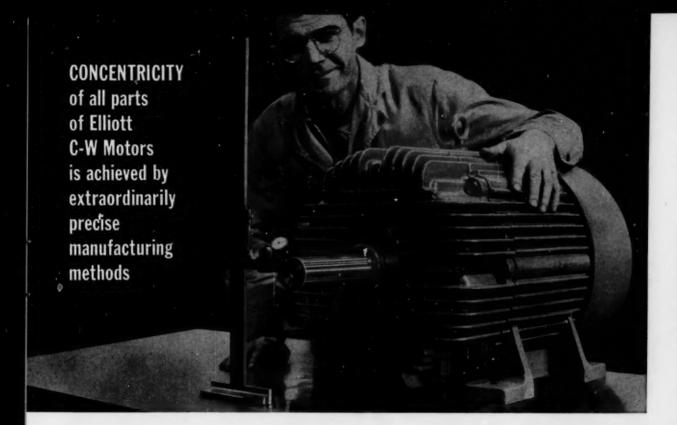


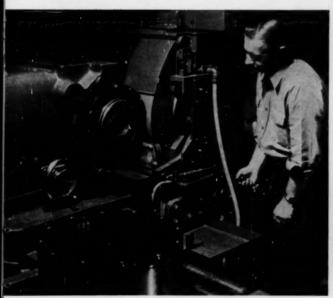
GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

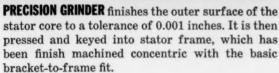
PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES - GENERATORS - MOTORS - COMPRESSORS - TURBOCHARGERS - EJECTORS - STRAINERS - TUBE CLEANERS

Circle 262 on Page 19







Key manufacturing operations employed in maintaining the required close tolerances are described more completely in an interesting brochure, *The Fine Art of Building Better Motors*. We will be very glad to send you a copy.





DUPLICATING the basic bracket-to-frame fit, a jig accurately positions the wound stator for finishing the inside core diameter by a "fly cutter," which corrects for all accumulated tolerances and assures precise concentricity.

	W1-
ELLIOTT COMPANY, J	
Please send a copy Motors to:	of The Fine Art of Building Better
Name	Position
Company	
Address	



Precision-Built Variable Speed Pulleys

- Stock delivery from the most complete line on the market—all sizes and types from ¼ to 25 hp., ratios up to 4 to 1 (7 to 1 Hi-Lo).
- Quickly and easily installed.
- Curved pulley faces maintain full belt contact at all speeds and pitch diameters to assure full transmission of rated power and longer belt life.
- Constant belt alignment is maintained by two precision calibrated springs which instantly adjust pulley halves to pitch diameter changes. This prevents side pull and reduces belt wear.
- Every pulley is dynamically balanced to .02 oz.-in. to assure quiet and trouble-free operation.
- Positive lubrication is provided by Alemite fittings on integral hp. sizes and Oilite bronze bushings on fractional sizes.
- Lovejoy Pulleys outlast equipment life.

Ask for recommendations on your application. Request Catalog B-61 and prices.







Lovejoy specializes in a full line of easily installed, maintenance-free power transmission equipment:



FLEXIBLE COUPLINGS any size or type, including specials, .003 to over 8500 hp. Request Catalog A-61.



UNIVERSAL JOINTS—for all industrial applications up to 1750 rpm., .35 to over 450 hp. Request Catalog D-61.



VARIABLE SPEED BELTS
—complete line of types
and sizes for all applications. Request Catalog
C-61.

Motor Bases Shaft Mounted Gear Reducers Take-Up Frames
Variable Speed Transmissions

Write or phone for literature and prices. If you have a specific requirement or problem ask for recommendations. No obligation.

LOVEJOY FLEXIBLE COUPLING CO.

4818 WEST LAKE STREET

CHICAGO 44, ILLINOIS

Telephone EStebrook 9-3010 • Teletype TWX-CG-85

SEE ALL TYPES OF POWER TRANSMISSION EQUIPMENT IN ACTION AT THE LOVEJOY BOOTH AT THE DESIGN SHOW

Working models of Lovejov Power Transmission Equipment will be on display at Booth 1044. In addition, many new items will be shown. These will include: (1) heavy-duty flexible couplings rated for applications up to 8500 hp.; (2) a unique line of low-cost variable speed pulleys designed for competitively priced equipment; (3) a new and complete line of variable speed belts; and (4) a recently introduced line of universal joints for industrial applications up to 1750 rpm., fractional to over 450 hp.

The Hi-Lo Manufacturing Company, affiliate of Lovejoy Flexible Coupling Company, will also display at Booth 1044. They will feature a complete line of camcontrolled variable speed pulleys ranging from fractional to 5 hp. with ratios up to 3 to 1, also a Hi-Ratio series up to 7 to 1.

Literature on these and many other types of power transmission equipment will be available. Experienced personnel and engineers will be on hand to answer questions, give recommendations and assistance. Bring in your requirements or problems. You'll receive prompt service.

Take advantage of this opportunity to get recently published Lovejoy material containing a wealth of information about power transmission equipment—plus first hand information. There'll be no obligation on your part, only service on our part at Booth 1044.

If you are unable to attend the show, write or call for literature or recommendations on the power transmission equipment you require. Address your letter to Lovejoy Flexible Coupling Company, 4818 W. Lake St., Chicago 44, Ill. Telephone EStebrook 9-3010.

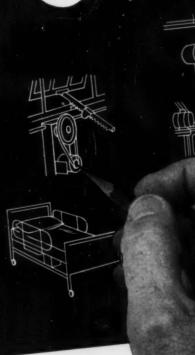
Franklineered. INSTANT-REVERSING MOTORS

Applicable to products requiring full-power, instant reversing with economies attendant to single-phase motors. 1/6 H.P. through 1 H.P., 1725 rpm, 115 or 230 V.

INST-O-VERSE® motors by Franklin utilize full torque instantly because there is no dependency on a relay or the delaying mechanical contact of the centrifugal switch. The INST-O-VERSE® device, preset by shaft rotation, reverses motor on automatic or manual signal.

INST-OFVERSE®

Encourages fresh thinking for new product design or to improved product performance-dependability. Write for facts brochure.





Franklin Electric Co., Inc.

BLUFFTON, INDIANA

DEPENDABLE MOTORS BACKED BY NATIONWIDE SERVICE

Philadelphia Spiral Bevel Reducers give you . . .

LESS HEAT LOSS LOWER POWER CONSUMPTION REDUCED PRIME MOVER COST LONGER LIFE

Looking for a better answer to your right-angle drive problems? Then check Philadelphia Gear, manufacturers of the most complete line of spiral bevel reducers available.

There's less heat loss, because Philadelphia Spiral Bevels deliver efficiencies of 95 to 98%. High efficiencies also mean you use less power... prime movers cost less and are smaller.

You'll get longer life because of the way Philadelphia Spiral Bevel Reducers are built. Bearings and shafting are designed for 185% overload. Spiral bevel gears and pinions are hardened after they are cut... then lapped to a mirror finish to assure the highest degree of gear accuracy.

Whatever your right-angle drive problem, solve it with Philadelphia Spiral Bevel Reducers. They will take more abuse and last longer . . . even under the most severe load conditions.

For information on the complete Philadelphia line... ratios from 1:1 to 238:1; single, double or triple reduction; vertical or horizontal...write on your company letterhead for catalog SB-69.



philadelphia gear drives

PHILADELPHIA GEAR CORPORATION

King of Prussia (Suburban Philadelphia), Pennsylvania



Single reduction horizontal



Double reduction horizontal



Triple reduction horizontal



Single reduction vertical



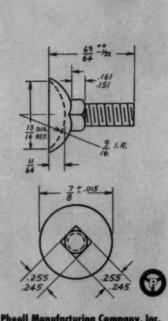
Double reduction vertical



Triple reduction vertical

Exclusively headed from **KEYSTONE WIRE**

5 T 0



Phooli Manufacturing Company, Inc.

Swivel base for truck rear view mirror passes toughest tests before it hits the road!

Pheoll Manufacturing Company, Inc., Chicago, Illinois, assigned to produce the square-shouldered cup screw shown here, asked Keystone Steel & Wire Company for the exact cold heading wire. Keystone's Metallurgists developed double extrusion coated special processed quality wire.

Finished product specifications called for a uniformly smooth cupped surface, free of burrs for proper adjustment of the mirror. This is consistently achieved by Keystone Wire's quality control during every step of wire manufacture from open hearth steel making to finished wire.

Because this cup screw must withstand the rigors of the road, it is given the toughest tests to check head stress and ductility. Held in a vise, the shank is struck repeatedly until it is bent 90° without fracture. The cup portion gets similar treatment.

The success of this cold-headed square shouldered cup screw is due to the superior flowability of Keystone Special Processed Wire, another example of proper chemical analysis, correct thermal treatment and consistent uniformity throughout every coil.

Why not take advantage of the service offered by Keystone Metallurgists who will analyze your specifications and recommend the wire just right to solve your particular wire problems? Talk with your Keystone Representative for complete details, or write us, sending your part and blue prints, if possible.

Keystone Steel & Wire Company, Peoria, Illinois

KEYSTONE

MANUFACTURED AT PEORIA, ILLINOIS, U.S.A.

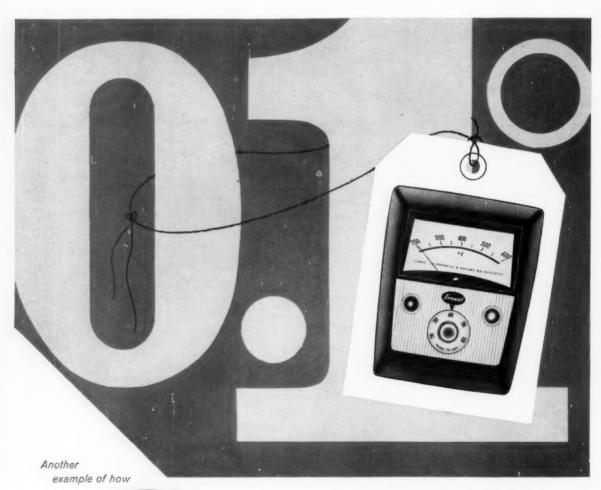
Here's 0.1° Sensitivity at a Competitive Price!

... Fenwal's New "561" Temperature Controller The new "561" indicating controller responds to temperature changes of 0.1° or less! And is yours at a competitive price! These two features alone make it an instrument you should investigate...but there's more!

You can choose from five standard temperature ranges . . . within the span of -50 to 600° F. Furthermore, scales start and end within your ranges, permitting larger graduations, better legibility, easier readout. And control and indication are separate but simultaneous. Should your indication fail the "561" will continue to control with complete accuracy.

This precise instrument gives unvarying performance. Its indication and control will not vary with fluctuations of input voltage nor changes in ambient temperature. It offers the option of either ON-OFF or proportional control . . . has 10 AMP/120 VAC relay capacity. Smartly styled to complement modern industrial machines and interiors, the "561" offers you all these extras at a competitive price.

A Fenwal engineer will be glad to supply information on the "561", or any other temperature control in Fenwal's broad line. Write Fenwal Incorporated, 195 Pleasant Street, Ashland, Massachusetts.





CONTROLS TEMPERATURE . . . PRECISELY





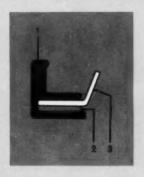
... Yet Costs No More! It's the seal of tomorrow for use today. Garlock P/S (Positive/Seal) KLOZURE Oil Seals with filled-Teflon** sealing elements offer the economical, built-in "permanence" demanded of modern design. They resist temperatures more extreme than ever encountered in normal operation; are chemically inert and unaffected by corrosion. They do not wear, nor score the shaft on which they are used; will seal at speeds to 3000 f.p.m. New Garlock P/S KLOZURE Oil Seals have been successfully tested on the GM Sealrater.

There's a lot more to the story of this fine new seal. Below are construction details; on the next page, you'll find application information. Send in the postcard and we'll send you an actual sample seal for examination. Garlock Inc., Palmyra, N.Y.



Garlock P/S KLOZURE construction assures positive sealing:

- STEEL SHELL OR CASE serves to enclose and position all component parts.
- SPECIAL GASKET fitted tightly into position holds sealing element in place, provides extra leakage protection.
- FILLED-TEFLON SEALING ELEMENT rides firmly against shaft, keeps oil in, dirt out.



PALMYRA, N. Y.

FIRST CLASS PERMIT NO. 2

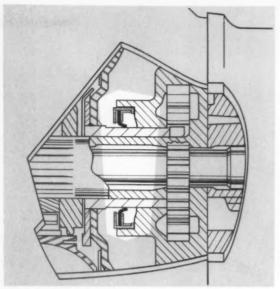
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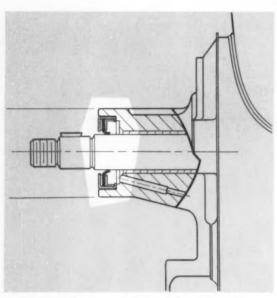
NEW P/S KLOZURE OIL SEALS



Cutaway shows general purpose seal in position. P/S KLOZURE Oil Seals outperform all others in standard 300-hour acceptance test.

FOR GENERAL PURPOSE APPLICATIONS . . .

. . . Garlock P/S KLOZURE Oil Seals outperform all others in a standard 300-hour acceptance test. Seals with synthetic rubber elements fail periodically, resulting in leakage. For example, nitrile rubber cracks and hardens; polyacrylate rubber loses its flexibility; silicone rubber swells and becomes soft. Garlock P/S KLOZURE Oil Seals emerge undamaged in tests run at 3600 r.p.m. speed on a 17/8" shaft. Shaft-to-housing eccentricity is .010" t.i.r.; seal-toshaft eccentricity is .010" t.i.r. P/S KLOZURE Oil Seals successfully resist Type "A" transmission oil at 300°F without harm or leakage.



Cutaway shows pump shaft seal in position. P/S KLOZURE Oil Seals outperform all others on standard 100-hour acceptance test.

FOR	PUM	P	SHAF	Т		
SEAL	ING	U	NDER	PRESSURE		

. . . Garlock P/S KLOZURE Oil Seals are the ideal answer to the combined problem of speed, pressure, and temperature. Undergoing a standard 100-hour acceptance test, P/S KLOZURE Oil Seals outlast the synthetic nitrile, polyacrylate, and silicone rubbers that are in popular use today. Test conditions in this instance are an 11 shaft rotating at 6000 r.p.m. with an eccentricity of .003" t.i.r. shaft-to-housing. Here again, Garlock P/S KLOZURE Oil Seals are unharmed against Type "A" transmission oil at a maximum of 275°F., pressure of 50 p.s.i. Of special interest to pump manufacturers is the universal suitability of this seal against all types of fluids, including non-flammable. No need now to match various sealing elements to various fluids-P/S KLOZURE Oil Seals handle them all!

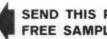
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fasteners you need to meet today's increasingly critical standards for precision, high strength, and trouble-free performance of the assembled product.

Find out how much you can save — in time, trouble, and assembly dollars — when you "Count on Continental." Write or phone: Continental Screw Co., 461 Mt. Pleasant St., New Bedford, Mass.

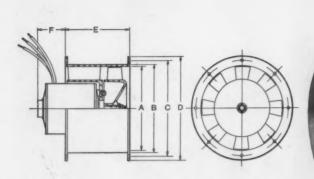
CONTINENTAL SCREW COMPANY

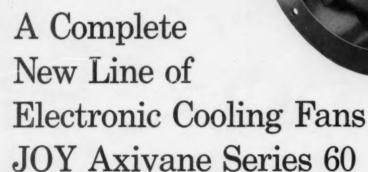
HOLTITE FASTENERS

HOLTITE PHILLIPS AND SLOTTED HEAD

WOOD . MACHINE . TAPPING . THREAD CUTTING . SEMS . NYLOK HY-PRO PHILLIPS INSERT BITS AND HOLDERS







Developed by Joy specifically for 60 cycle commercial duty, the Series 60 vaneaxial fans operate at 3400 rpm, 115 volts, single phase, 50/60 cycles and produce from 50 to 500 cfm at static pressures of ¼" through 1" wg. They are extremely compact and ruggedly built

of anodized aluminum. There are only four major parts; rotor, housing, motor, and separately mounted capacitor. Production quantities are available on order and small quantities are available off-the-shelf. For more information write for bulletin 2518-64B.

Model No.	Design CFM ±3%	Max. CFM at Free Flow	Design PS ± 7%	Max. Pressure	Motor Data		Mechanical Dimensions (Inches)					1/32"Holes		
					ВНР	CAP*	A	В	C	D	E	F	Per Flange	Weight Pounds
X702-401	50	70	0.30	0.45	.005	NONE	4.37	4.62	5.25	5.87	4.50	0.9	4	5.4
X702-402	100	145	0.35	0.60	.010	NONE	5.12	5.37	6.00	6.62	4.50	0.9	4	5.8
X702-403	150	180	0.35	0.80	.015	NONE	5.62	5.87	6.50	7.12	4.50	0.9	4	6.1
X702-404	200	265	0.40	0.79	.035	5	5.62	5.87	6.50	7.12	5.00	1.3	8	7.2
X702-405	250	330	0.40	0.82	.043	5	5.87	6.12	6.75	7.37	5.00	1.3	8	7.4
X702-406	300	340	0.40	0.93	.052	5	6.12	6.37	7.00	7.62	5.00	1.3	8	7.6
X702-407	350	430	0.50	1.10	.060	5	6.37	6.62	7.25	7.87	5.00	1.5	8	8.5
X702-408	400	520	0.75	1.20	.068	5	6.62	6.87	7.50	8.12	5.00	1.5	8	8.7
X702-409	450	560	0.75	1.30	.075	5	6.87	7.12	7.75	8.37	5.00	1.5	8	8.9
X702-410	500	625	0.75	1.40	.083	5	7.12	7.37	8.00	8.62	5.00	1.5	8	9.1

*Rated 236 WVAC-

Note: Spun aluminum inlet bells and aluminum wire inlet bell screens are available to fit all sizes of fans.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY









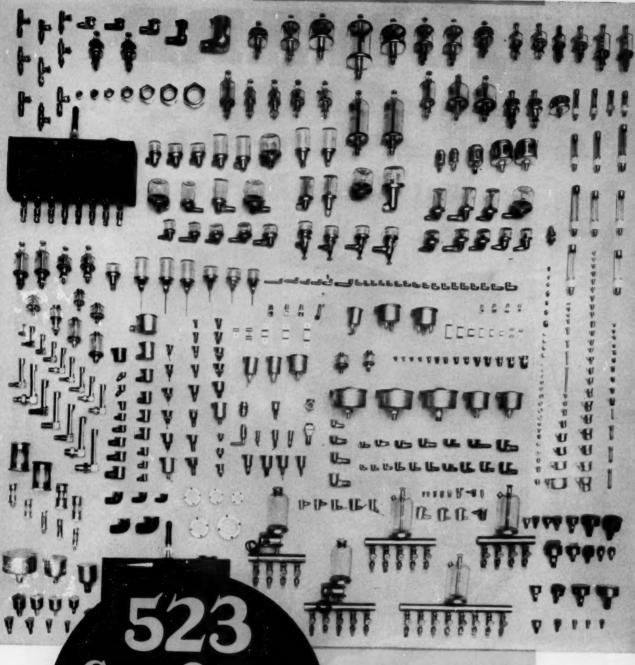




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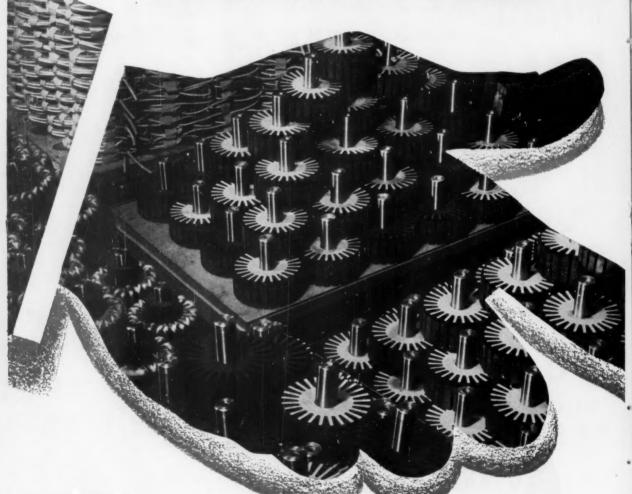


GITS BROS. MFG. CO. Circle 272 on Page 19

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CYCLOHM MOTOR CORPORATION

RACINE ELECTRIC PRODUCTS

1/200 TO 1 H.P. · HIGH SPEED · HIGH STARTING TOROUE



MODEL 29-500 TYPE: Universal AC/DC or Shunt. DIAMETER: 3-5/16. LENGTH: 4-11/16 to 5-19/32. Shunt or Compound—1/12
Intermittent Series—1/6 @ 10,000 R.P.M.
Shunt or Compound—1/12
Intermittent Series—1/4 @ 10,000 R.P.M. Shunt or Compound—1/6.

SPEED: No Load: Series—15,000 R.P.M.
Shunt or Compound—12,000 R.P.M.
Full Load Speed: Series—3000 to 10,000 R.P.M.

R.P.M.
Shurt or Compound—1000 to 10,000 R.P.M.
VOLTAGES: Series—6 to 250V. AC/DC.
Shurt or Compound—6 to 230V. DC.
BEARINGS: Porous bronze sleeve type or grease sealed ball bearings.



MODEL 700

TYPE: Universal AC/DC or DC Shunt DIAMETER: 3.800". LENGTH: 5-7/64". to 6-7/64". H.P.: Continuous: Series-1/4 @ 10,000 R.P.M. Shunt-1/8. Intermittent: Series-1/2 @ 10,000 R.P.M. Shunt-1/4. SPEED: No Load Speed: Series-18,000 R.P.M. Shunt-2000 to 12,000 R.P.M. Full Load Speed: Series—5000 to 10,000 Shunt—1000 to 10,000 R.P.M. Shunt—1000 to 10,000 k.F.M.

VOLTAGES: Series—6 to 115V, AC/DC.

Shunt—6 to 230V. DC.

BEARINGS: Greage sealed ball bearings.



MODEL 1100 TYPE: Universal AC/DC or DC Shunt.
DIAMETER: 2-13/16". LENGTH: 3-9/16".
H.P.: Continuous: Series—1/50 @ 10,000 R.P.M. Shunt-1/50. Intermittent: Series-1/15 @ 10,000 R.P.M. Shunt-1/15. SPEED: No Load: Series-15,000 R.P.M. approx. Shunt-3500 to 12,000 R.P.M.
Full Load: Series-3000 to 10,000 R.P.M.
Shunt-2000 to 10,000 R.P.M. VOLTAGES: Series-6 to 230V. AC/DC. Shunt-6 to 120V. DC. BEARINGS: Porous bronze sleeve type, or Grease Sealed Ball Bearings.



MODEL 243

TYPE: Universal AC/DC or DC Shunt. DIAMETER: 2-17/32. LENGTH: 3-15/16. H.P.: Continuous Series—1/12 @ 10,000 R.P.M. Intermittent—1/8 @ 10,000 R.P.M. SPEED: Full Load Speed: Series-5000 to 10,000 R.P.M. Shunt-2000 to 7000 R.P.M.

VOLTAGES: Series—12 to 230V. AC/DC. Shurt of to 120V. DC.
BEARINGS: Porous bronze self aligning type with oil reservoir.



MODEL 200

TYPE: Universal AC/DC or DC Shunt. DIAMETER: 1-11/16". LENGTH: 2-11/16". H.P.: Continuous Series-1/200 @ 10,000 R.P.M. Shunt-1/200. Intermittent: Series-1/75 @ 10,000 R.P.M. Intermirent: Series-1/73 @ 10,000 R.P.M. Shunt-1/75. SPEED: No Load Speed: Series-15,000 R.P.M. Shunt-15,000 R.P.M. Full Load Speed: Series-5000 to 10,000 Shunt-3000 to 10,000 R.P.M VOLTAGES: Series -6-115V. AC/DC. Shunt-6 to 32V. DC. BEARINGS: Grease sealed ball bearings.



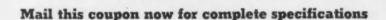
MODEL 512

TYPE: Universal AC/DC or DC Shunt DIAMETER: 3-3/8". LENGTH: 4-3/4" H.P.: Continuous Series—1/10 @ 10,000 R.P.M.
Shunt—1/12 Shunt-1/12. Intermittent: Series-1/5 @ 10,000 R.P.M. Shunt-1/6. Shunt—1/0.

SPEED: No Load Speed: Series—15,000 R.P.M.
Shunt—2000 to 12,000 R.P.M.
Full Load Speed: 5000 to 10,000 R.P.M.
Shunt: 1000 to 10,000 R.P.M. VOLTAGES: Series—6 to 230V, AC/DC. Shunt—6 to 120V. DC. BEARINGS: Porous bronze sleeve type.

MODEL 200

☐ MODEL 1100



HOWARD INDUSTRIES, INC., 1735 STATE STREET, RACINE, WISCONSIN

Please send me complete information on:

☐ MODEL 243 ☐ MODEL 700

MODEL 29-500 MODEL 512

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The Products with the Pluses

- and how long will the

flexing member last?

Good question. The heart of Para-flex is a tire with synthetic tension members bonded together in rubber — which provides a flexing body that automatically compensates for all combinations of misalignment and end float, and absorbs vibration as well!

This amazing coupling has now been used in American industry 4 years. Thousands are in operation - in steel mills, paper mills, oil fields, mines, quarries, chemical plants, everywhere—and in these 4 years, replacements of elements have been negligible.

Dodge Standard Para-flex takes angular misalignment up to 4°, parallel misalignment up to 1/8" and end float up to 5/16" depending upon the size of the coupling and the duration of shaft displacement.

Dodge Para-flex is available in 3 types-Standard, Flywheel and High Speed (shown at right). The Standard type is stocked in capacities up to 3640 hp at 910 rpm. Ask your Dodge Distributor, or write us for complete technical bulletin.

Dodge Manufacturing Corporation, 3300 Union Street, Mishawaka, Indiana



The new idea in flexible cushion couplings, with a flexing member that "swallows up" misalignment.



No lubrication, no maintenance. Replace flexing element without moving driver or driven machine.





REE THIS VALUABLE BOOKLET



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of data
on new ways
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Exactly how do Boosters save space, weight, air, cut costs, increase efficiency, reduce maintenance? How do they provide smooth hydraulic power (up to 10,000 psi or more) from your shop air and maintain pressure without heat generation or additional power consumption? Exactly how and where are they now being used? The whole absorbing story is told in color—along with full information on available models, dimensional data, pricing, etc.—in this new interesting booklet specially prepared for busy, time-short designers, engineers, and production men. Write today for your free copy.

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AIR AND HYDRAULIC CYLINDERS - ACCUMULATORS
COUNTERBALANCE CYLINDERS - BOOSTERS

new-lube-free...



...Sterling's variable speed drive never requires lubrication

Costs Reduced—One of management's biggest headaches has been the development and maintenance of proper lubrication schedules. As a consequence, lubrication problems have long been the cause of variable speed drive failures, pulley wear, sticky pulleys, shortened belt life, excessive noise, and many other equally costly problems.

High labor costs, coupled with increased maintenance needs, are major management problems.

Lubrication Eliminated—Now, Sterling has eliminated all lubrication maintenance problems. No part of a Sterling variable speed drive needs to be lubricated.

All bearings, sealed and shielded, are factory-lubricated and therefore require no lubrication. Shaft surfaces are impregnated with a special exceptionally tough and wear-resistant material which eliminates need for lubrication. The non-metallic bushings are also fabricated from a special material that is equally wear-resistant.

Special Load-Bearing Surfaces—At no time do these surfaces require any attention. Even the keys are fabricated from a tough elastic material and will not wear out.

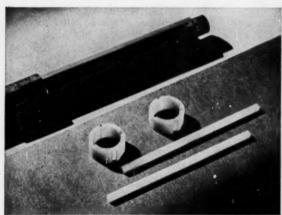
Fret corrosion, long a problem with metallic load-bearing surfaces, is completely eliminated since non-metallic surfaces now carry the load. Sticky pulleys, frequently the result of improper lubrication, are no longer a problem.

Sterling's new "Lube-Free" variable speed drive can be installed in any location, no matter how inaccessible, since lubrication maintenance is no longer needed.

Other Benefits—Costs are reduced, money saved, when lubrication maintenance is no longer necessary. Belt life is lengthened; pulley wear is eliminated. Bearing life may also be lengthened by the elimination of worn pulleys—often the cause of vibration and bearing wear.

All other Sterling variable speed advantages are present in this new "Lube-Free" drive: wide range of speeds, heavy duty cast iron case, finger-tip speed control, etc.

Information Available— Complete application and product information is available by writing Dept. D-1, Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, California—or by contacting the Sterling field engineer in your area.



Shaft surfaces are extremely tough; material provides unusual chemical resistance and anti-frictional properties that make an excellent load-bearing material operating under extremely low or high temperatures. Keys and bushings are fabricated from a material proven to have outstanding abrasion resistance; holds up indefinitely under frictional conditions, thus eliminating need for lubrication.



This V & O Notching Press is powered by a new Sterling "Lube-Free" variable speed drive. It will never need lubrication. Similar units have been installed in the food processing industry. The elimination of lubrication is particularly important in the food processing industry where variable speed drives have such wide application, and where oil and grease create sanitation problems.



Sterling Electric Motors, Inc.

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Only Curtiss-Wright Clutches combine ALL these advantages in every size and type:

Instantaneous, positive gripping action that eliminates slippage, wear and lost time in cycling operations . . .

High speed operation with negligible centrifugal throw-out action . . .

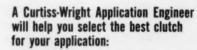
Requires only occasional lubrication and can be located in inaccessible places . . .

Smaller, lighter and more compact per inch-pound of transmitted torque . . .

Low maintenance and long life at constant torque . . .

Lower cost than other types of clutches with comparable torque rating . . .

Versatile Curtiss-Wright clutches can be used to solve many clutching or braking problems. All standard types available in torque capacities from 8 to 1250 pounds-inches.



OVER-RUNNING—BACKSTOPPING for transmitting power during low speed cycle; and over-running during high speed cycle; for use when a reversing motor drives two different mechanisms; to maintain one-direction shaft rotation.

INDEXING for accurate intermittent or indexing motion.

ON-OFF for selectively driving and disengaging in the same direction, where the driven member coasts.

ON-OFF INDEXING for selectively driving and disengaging in the same direction, when driven member must not coast.

INDUSTRIAL SAFETY-LOCK for bi-direction control of rotary motion.

SPECIAL PURPOSE clutches custom designed to specification.



Write today for a complete catalog of Curtiss-Wright Clutches, or for consultation with a Marquette Division application engineer. MARQUETTE DIVISION

CURTISS WRIGHT

CORPORATION

1145 Galewood Drive, Cleveland 10, Ohio



A new concept in air distribution pioneered by Carnes Corporation of Verona, Wisc.—made a reality by LEXAN polycarbonate resin!

In Carnes' design, 6-by-6-inch air diffusers, like those above, form modular units which can be arranged in any desired ceiling pattern. Three different module designs provide complete flexibility in directing air.

"LEXAN resin is the only material we have approved for our diffusers," says Gordon Sylvester, Chief Product Engineer of Carnes. "We tried polystyrenes, polyethylene, nylon and others, but they all fell short in one way or another."

The material for Carnes' diffusers

had to meet this combination of requirements: • INJECTION MOLDING for low production cost. LEXAN resin, as a thermoplastic, gave this advantage. • NO HEAT DISTORTION in 225°F. test for handling warm air. In month-long tests of parts, LEXAN resin met this spec. Actually, the resin's rated distortion point is 270-280°F. under load. · DIMENSIONAL STABILITY in use. LEXAN resin was stable. • FLAME RETARDANCE to pass ASTM test. LEXAN resin passed. . COLOR STABILITY and versatility. Although the modules are now a stable white, LEXAN resin offers the possibility of a wide range of colors. • HIGH IMPACT RESISTANCE. Frank Freese, Product and Merchandising Manager for Carnes, really sells LEXAN resin's enormous impact

strength. He says "In demonstrating the strength of the modules, we slam them against the wall. It doesn't damage them at all. Metal diffusers would be bent by this treatment."

LEXAN resin has raised the quality of many designs to new levels. It's been substantially reduced in price as new G-E plant facilities have come onstream. Can this tough new thermoplastic help you? Send for design literature. Address General Electric Company, Chemical Materials Dept., Section MD-51, Pittsfield, Mass.

LEXAN'

Polycarbonate Resin

GENERAL 🚳 ELECTRIC

Circle 278 on Page 19

TO INSURE SUCCESSFUL PERFORMANCE



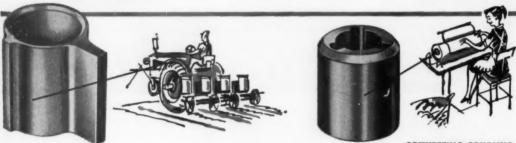
One of the most important factors to consider when purchasing powder metal parts is that of successful part performance; for a part to successfully perform its job, all of its physical and metallurgical characteristics must be suited to the application.

GRAMIX Products of Powder Metallurgy are always Application Engineered, which means product is specially matched to each specific application. From an almost unlimited variety of metal mixtures, one alloy is blended that contains the required properties and characteristics of the finished part; all aspects of part design

and conditions under which it must operate are taken into account. Only then is the GRAMIX part produced.

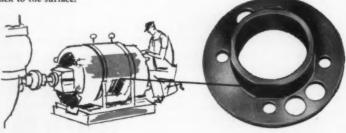
Eight of these Application Engineered GRAMIX parts are shown here. Each precisely suits the requirements of its job... each is the best part available for the job.

When you specify a GRAMIX part, you can always be sure that it has been *Application Engineered* for successful performance, long life and complete reliability. For more information on *Application Engineered* GRAMIX parts, write for Engineering Handbook G-55.



CORN SEEDER

GRAMIX was the material specified for this corn seeder part because the surface finish obtainable with the alloy used reduced the tendency of material to stick to the surface.



CONNECTING COUPLING

The connecting coupling employed in a small home ironer is formed from a special GRAMIX hardened steel alloy; it offers low wear and shock resistance.

CONTAINER COVER END CAP

Great savings were realized when retainer caps for certain types of electric motors were made of GRAMIX.

This process made it simple and economical to mold the multiple holes to precise tolerances without extra operations.

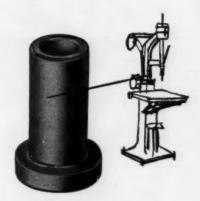


HELICOPTER THRUST WASHER

The outstanding features of the GRAMIX alloy specified for this thrust washer are a dependable and consistent friction and wear pattern as well as a fine surface finish.

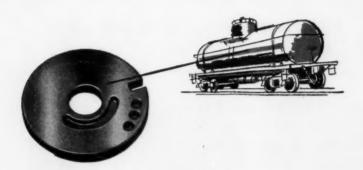


One of the important requisites in a tape recorder is a low noise level. United States Graphite Company engineers developed a special alloy to meet these requirements in the GRAMIX spindle.



GUIDE BEARING

Built-in lubrication and low friction to reduce heat are important features of the GRAMIX alloy chosen for this guide bearing.



LIQUID PUMP END PLATE

This end plate is typical of many parts employed in liquid pumps of many types.

It is made from a wear resistant bronze alloy that was developed for pump applications.



FRACTIONAL H.P. MOTOR

The GRAMIX bearing for this Fractional h.p. motor was developed from a special low noise level alloy.

Its self-lubricating properties were also an important consideration in specifying GRAMIX.

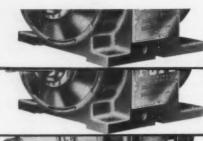


X-296-2

THE UNITED STATES GRAPHITE COMPANY



DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



ANNOUNCING...

A NEW LINE OF



Bobby,



PRECISION MOTORIZED SPINDLES



.000025" (twenty-five millionths) vibration amplitude .000075" (seventy-five millionths) shaft runout 1 to 20 horsepower — 900 to 3600 r. p. m.

Use this heavy duty, motorized unit for a wide variety of precision grinding and cutting operations.

Use it to drive precision machine tool spindles, test apparatus or research equipment.

Use it wherever low amplitude of vibration and extra rigidity mean more profit for you through better, faster production.



Bulletin S-23 gives you complete information, dimensions and specifications. May we mail you a conv?

This Pope Precision Motorized Spindle is equipped with a Pope balancing type wheel holder for precision grinding.



NO. 135



PRECISION ANTI-FRICTION BEARING SPINDLES
FOR EVERY PURPOSE

POPE MACHINERY CORPORATION . 261 RIVER STREET . HAVERHILL, MASS.

FOR EXACTING SERVICE WHILEY

CONTROL VALVES

Tubing feature usual and unusual metals with Swagelok Tube



For years, WHITEY RESEARCH TOOL CO. has used exceptional machining and engineering skill to produce valves in new alloys that most manufacturers hesitate to machine. Monel, Hastelloy, Inconel and Nickel require top skill. It is through this manufacturing skill that quality performance is combined with quality appearance to provide precision, leak-tight WHITEY Valves to meet your most exacting system requirements.

WHITEY Valves are available in straight and angle pattern styles with 1/2" through 1/2" SWAGELOK Tube Fitting connections or 1/8" through 1/2" male and female pipe connections.

Panel mounting; Teflon* cylinder packing; micro-regulating and non-regulating stems are standard features on all WHITEY Valves. Colored handles, to permit color coding, can be specified when ordering.

Pressure ratings of WHITEY Valves range from 3,000 p.s.i. to 5,000 p.s.i. All WHITEY Valves are available with SWAGELOK Tube Fitting connections for efficient, leakproof installation.

COMPLETE TECHNICAL DATA ON WHITEY VALVES AVAILABLE ON REQUEST.

*Dupont Trademark

WHITEY RESEARCH TOOL CO.

Circle 281 on Page 19

5525 MARSHALL STREET OAKLAND 8, CALIFORNIA





Madison-Kipp zinc and aluminum die castings

These five castings assembled in the order that you see them are engineered for a radial arm saw. Intricate in design, they must match perfectly and that means extremely close tolerances. Mass production demands a minimum of secondary operations.

This is just one example of the wide range of castings that Madison-Kipp is called upon to engineer

and produce—in quantity. All, however, have one thing in common—the need of a dependable source with years of seasoned experience in producing die castings.

We have a 24-page book showing some of the die casting problems we have solved, and containing information on other Madison-Kipp products. A copy is yours for the asking. Write for one.



MADISON-KIPP CORPORATION

210 Waubesa Street . Madison 10, Wisconsin, U.S.A.

Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High-Speed Air Tools

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Circle 282 on Page 19

MACHINE DESIGN

NEW from Square D...

A SMALLER 10 AMP RELAY-WITH INDUSTRIAL FEATURES!



Terminal or Plug-In Wiring

- RATINGS easily handle solenoid loads.
 AC pilot duty rated 690 VA. Continuous rating 10 amperes, 125 volts AC for plug-in construction and 277 volts AC for terminal connection
- Long Life makes suitable for rugged machine tool applications
- Molded coll operates cooler and keeps out moisture for longer life
- . No solder joints to break
- Optional pilot light indicates when relay is energized
- Durable nylon dust cover won't break, crack or support combustion

ALL THESE VARIATIONS OF WIRING AND MOUNTING



PRESSURE



BINDER HEAD SCREWS



SLIP-ON CONNECTOR



PLUG-IN



Write FOR DETAILS! . Square D Company,

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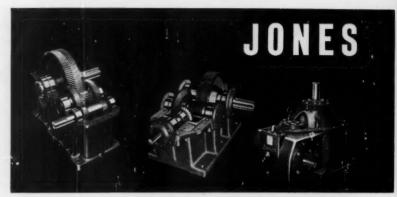
SQUARE TI COMPANY

wherever electricity is distributed and controlled

How

THE BROAD H-R LINE

can pinpoint
your needs,
save you time
and give you
off-the-shelf
savings.



Jones herringbone reducers . . .

Ruggedness and reliability, known throughout industry. Widest selection of sizes and ratios. Balanced design, rugged housing, heavy-duty bearings mean efficient, trouble-free operation, and longer life. Capacities to 1,672 hp. Bulletin J-100.

Jones spiral bevel speed reducers . . .

Most-up-to-date design. Horizontal or vertical outputs. New, highly efficient right angle drives. Matched sets of high-hardness spiral bevel gearing, oversize bearings, alloy steel helical gearing. Capacities to 1,050 hp. Bulletin J-25.

Jones worm helical speed reducers . . .

Heavy duty service. Applicable to a wide range of vertical drive requirements where medium to high speed reduction ratios are needed. Available in low speed shaft extension up, down, and double extended. Capacities to 175 hp. Bulletin J-14.



Union ASA standard roller chain...

Over 98% efficient, Union ASA standard roller chain transmits more horsepower in less space than many other mechanisms. Available in outstanding range of pitches and widths, ASA standard and ASA heavy series, and extended pitch. Bulletin RT-60.

Roller chain attachments...

An almost unlimited variety of unusual drive and conveying problems can be solved with standard or special attachments by Union Chain.

Bulletin RT-60.

Union roller chain sprockets...

Complete range of stock and special sprockets for all chain applications. Precision teeth, tough, durable body, proper tooth surface hardness make for long life and economy. Available also in Taper-Lock bushings. Bulletin RT-60.

YOUR H-R POWER TRANSMISSION SPECIALIST CAN SHOW YOU HOW...

to select the ratio, capacity, and design closest to your needs . . . directly from H-R standard equipment . . . and at "off-the-shelf" savings.

Another point in your favor: your H-R power transmission specialist is in the best position to help you

select the right drive. He can recommend without bias, because the H-R line is one of the most comprehensive in industry. Experienced in all phases of power transmission, he can be invaluable in helping you with your over-all drive problem. Important too, he has Hewitt-Robins service and reliability behind him!

Availability? H-R warehouses, sales offices, and stock-carrying distributors spread a strategic network from Coast to Coast. There is a team of H-R

SPEED REDUCERS

Jones shaft-mounted reducers . . .

Compact design for confined areas. High hardness gearing for long life. Double lip oil seals, anti-friction bearings, automatic overload mechanism, positive lubrication. Torque-arm for simple belt tensioning adjustment. Capacities to 40 hp. Bulletin J-19.

Jones in-line helical reducers...

Standardized components, both in-line and right angle reducers to meet any drive requirement. Easy-to-change ratios. One-piece, cast housing, positive gear and shaft alignment, reliable oil-sealing. Capacities to 147 hp. Bulletin J-18.

Jones gearmotors . . .

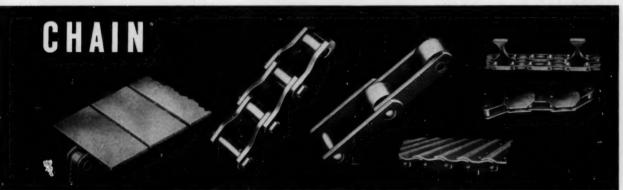
Horizontal or vertical, flange or foot-mounted. Two basic types: All-motor... has motor mounting bracket for foot-mounted motor. Integral... incorporates flange-type motor bolted directly to gearhead housing. Bulletin J-17.

Jones power transmission components . . .

Pillow blocks for heavy-duty service. Timken tapered roller bearings, two-piece, cast iron housing, shaft sizes from 1 15/16" to 9". Flexible couplings, gear tooth, fabric disc... V-belt drives... cut tooth gears... cast iron pulleys. Bulletins J-10A, J-16, J-23.

Jones complete drive units . . .

Safe, efficient special drives, feeder tables, car pullers, door, boom, and skip hoists. Feature rugged reliability of Jones speed reducers. Standard lines available or modifications of existing equipment at considerable savings. Bulletins J-11, J-22.



Union ASA standard flat top roller chain...

Now available in Delrin, (as well as other materials) reduces breakage and eliminates corrosion problems in many food, beverage, and pharmaceutical conveyor applications. Available in many combinations of chain and materials. Bulletin RT-60.

Union HB steel drive chain...

At home in heavy duty service, such as cement mixers, cranes, shovels. Offset side-bar adds to flexibility. Hardened bearing for rugged wear. Pitches from 1.6" to 6.0". Average ultimate tensile as high as 420,000 psi! Bulletin A-4.

Union HB steel roller chain...

Low ultimate cost in all types of elevating and conveying duty. Hardened alloy steel bushings, uniform wearing surfaces, true pitch accuracy, tight fit of pins and bushings. Bulletin A-4.

Union apron conveyors . . .

Many types available. Union apron conveyors for bulk or packaged materials. Bulletin A-4.

Union "Made-to-order" chain . . .

Meet unusual requirements. Union Chain Division of Hewitt-Robins, unlike many manufacturers, is able to design and produce special chains to meet special needs. Bulletin A-4.

power transmission specialists in your territory. To put them to work for you, just give your nearest Hewitt-Robins Sales Office a call.



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ANSWERS to specific fastening problems ... by SIMMONS

Economy, design flexibility, quick and easy installation, strength, and smooth, dependable action are advantages of these Simmons Fasteners, made for a variety of special applications. Whatever your fastening problem, engineering aid is available from Simmons.



HOOK-LOCK-Springless, positive-locking latch which lies flat against mounting surface, open or closed. Provides high closing pressure and loadcarrying capacity. For military as well as commercial container applications.



SPRING-LOCK-Perfect. proved blind rivet for removable covers and panels on electric and electronic equipment, sheet-metal automobile parts, appliances.

Plastic Spring-Lock Shelf Supports with "heart of steel" help refrigerator makers cut costs, speed production, simplify servicing.





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LINK-LOCK-Ideal latching device where heavy locking pressure is necessary. Available in heavy, medium, light duty, for use in military and commercial containers and demountable construction.



DUAL-LOCK-Impact and vibration-proof high-load butt-joint fastener that will not accidentally unlock or loosen. Recess in panels or surface mount. Withstands 7000-lb. tension.

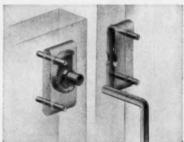


QUICK-LOCK-For assembling removable panels and access doors. Locked by a 90° turn. Various sizes and types, for weather-tight electrical units, cowlings, access panels.





HINGE-LOCK-A rugged pressure hinge which provides a strong seal along the hinge line of gasketed equipment containers and transit cases. Matched hardware with LINK-LOCK.



ROTO-LOCK-Versatile fastener for butt or right-angle joints in portable shelters, partitions, knock-down shipping boxes, etc. Solidly built, springless.



CLAMP-LOCK-A simple and strong, positive-locking clamp for fast assembly (and disassembly) of permanent or temporary rooms and buildings of flanged-panel construction.

DESIGN ENGINEERING SHOW

SIMMONS FASTENER CORPORATION

1756 North Broadway, Albany 1, New York

there are always good reasons for designing it in

polypropylene



This polypropylene trap catches all foreign items and prevents gurgling in RCA Whirlpool's 1960 Automatic Washer. AviŞun Polypropylene's excellent molding characteristics make possible the intricate, cost-saving design of the molded-in baffle and air vent. Custom-molded by Precision Plastics, Columbia City, Ind.

in RCA Whirlpool washers

<u>it's heat and</u> <u>chemical resistance</u>

RCA Whirlpool engineers selected AviSun Polypropylene #1014 over all other materials for this hard-working automatic washer part. It withstands highest water temperatures—resists all common detergents and bleaches—shrugs off tough battering by coins and other items left in clothes. And, it's more economical to manufacture and install.

Polypropylene makes better products at lower cost. No other material has this combination of properties:

- 1. Heat Resistance
- 2. Chemical Resistance
- 3. Toughness
- 4. Economy

AviSun polypropylene is being used in new applications every day—from Pulspirators to TV backs. New production facilities, now under construction, will soon be ready to meet the growing demand for this versatile new material. Send for Booklet AP-601, giving complete information on AviSun polypropylene.

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1 TO 5 TON CAPACITIES 3 BASIC SERIES

Each powered by the toughest engine in its class

Wherever you have an air conditioning or refrigeration problem for equipment on the move, or installations in remote regions where electricity is not a practical source of power, solve your problem with one of these gasoline or natural gaspowered Onan Engine-Compressors:

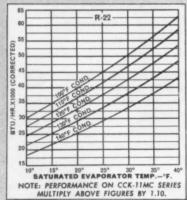
AJ-MC Series—5,000 to 15,000 B.T.U./1 hr. capacities.

LK-MC Series—10,000 to 30,000. CCK-MC Series—15,000 to 60,000.

Built as compact, light-weight units, engines and compressors are directcoupled and permanently aligned for continuous, trouble-free service.

The AJ-MC series uses the AJ engine rated—4.3 BHP at 2600 RPM. The L.K.-MC series uses the LK engine rated—6.8 BHP at 2400 RPM. The CCK-MC series uses the CCK engine rated—12.5 BHP at 2400 RPM. These are low-fuel consumption engines that have distinguished themselves around the world in Onan Electric Power Plants. Engines are superior for driving compressors and electric plants because they are specifically designed for sustained operation in the 1800 to 2600 RPM range. Each the toughest engine in its class because of Onan features such as big, brawny bearing surfaces . . . exhaust valves and seat inserts of Stellite, one of the toughest alloys known, for up to 3 times the valve life . . short, extra heavy-duty crankshafts.

CHECK THESE TYPICAL PERFORMANCE CHARACTERISTICS OF MODEL CCK-10MC



CALL BOB WESTRUM. He's an expert in solving Engine-Compressor problems for Original Equipment Manufacturers. Minneapolis, FEderal 2-1155. Or write.

Cool ém anywhere with Onan's Unitized Engine-Compressor

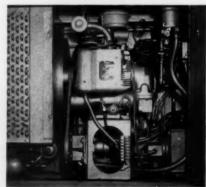
Direct coupled. Permanently aligned. Here's the dependable self-powered compressor for air cooling or refrigeration equipment. Powered by rugged, Onan-built engines.



PROTECT THAT PAYLOAD. Perishables on the move need dependable refrigeration. That's why you'll see Onan equipment on numerous "reefer" rigs across the nation. Got a mobile cooling, freezing or air conditioning problem? Let Onan help.



MADE FOR EACH OTHER. Onan gives you true integrated design—both engine and compressor—all in compact, smooth-running unit. Eliminates belts and couplings.



CRAMPED FOR SPACE? Compact Model CCK-MC (2-cylinder air cooled engine, 2-cylinder compressor) nestles in box up front. More payload—less installation costs.



Onan Division,

Studebaker-Packard Corp. 2723 University Ave., S.E., Minneapolis 14, Minn.

Circle 287 on Page 19

LET MUELLER MAKE IT!

Mueller Brass Co. of Port Huron is much more diversified than the name "Brass" implies . . . a lot more. In fact, because of its many and varied facilities . . . its men, methods and metals . . . Mueller is in the unique position of being able to offer true single source service.

MUELLER HAS THE MEN... experienced engineers with the ability to work out, creatively, tough design problems, and improve a part or components for production by the most economical method. You get sound engineering plus 44 years of practical metalworking production experience when you "Let Mueller Make It".

MUELLER HAS THE METHODS . . . when you "Let Mueller Make It", you are utilizing one single source that is able to produce parts any one of these ways: as forgings, impact extrusions, sintered metal parts, screw machine products, formed tube or as castings.

MUELLER HAS THE METALS . . . and the materials . . . to produce precision parts in aluminum, brass, bronze, copper, iron and steel in hundreds of different alloys to meet each exact requirement.

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YOU CAN ADD THIS ENGINEERING TEAM TO YOUR STAFF WHEN YOU

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When you work with the Mueller organization, a qualified team of trained, experienced and imaginative engineers automatically become part of your staff and go to work for you. This engineering team, which includes specialists in all categories of design work and production procedures, carefully considers all aspects of your particular part or assembly and its function. In conjunction with members of your engineering department, Mueller engineers can help design or re-design your part for improved performance, eliminate, where possible, unnecessary parts through re-design by making two or three part assemblies as a single piece, and recommend the best method of production. Mueller people also consider ways of speeding your finishing and assembly operations. Production economies consistent with product quality are always a prime consideration.

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the new MICRO-MASTER° 35mm Camera-Projector by K&E

FIRST with fluorescent lighting. Eliminates hot, troublesome reflector floods, gives better

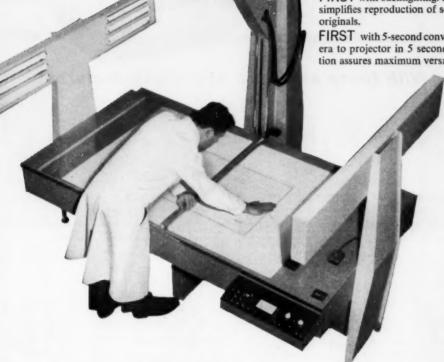
FIRST with curved-field lens. Assures last bit of resolution out of image for highest quality blowbacks.

FIRST with vacuum subject-holder. Holds copy perfectly flat from edge to edge, assures sharper negatives every time.

FIRST with motor-driven projector. Film moves backward or forward for projection at the touch of a button.

FIRST with backlighting. Increases contrast, simplifies reproduction of soiled or two-sided

FIRST with 5-second conversion. From camera to projector in 5 seconds-simple operation assures maximum versatility and output.



A host of technical firsts and finests make this the most efficient 35mm unit yet perfected. Specifically tailored for engineering miniaturization and reproduction, the new MICRO-MASTER 35mm Camera-Projector enables greater accuracy than any other 35mm unit. The more you learn about this new unit,

the more you'll want it. To get the full story, see your local K&E dealer, or fill out and mail the coupon below:



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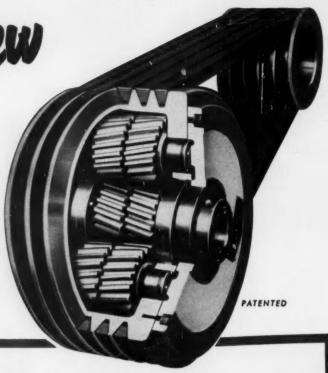
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Please send me complete descriptive literature on the new MICRO-MASTER® 35mm Camera-Projector by K&E.

Name & Title:

Most versatile transmission ever developed!



With these standard accessory features



SPRING REACTION ARM

Incorporates a series of leaf springs which provide progressive overload capacity, reduce shock loading, and prevent internal damage to the unit.



FRICTION REACTION ARM

A spring-loaded friction clutch combined with the reaction arm assembly. Designed to slip at a preselected torsional overload. Restores normal operation automatically when overload ceases.



MANUAL FRICTION CLUTCH

Permits manual engagement and disengagement of the unit. Provision is made for adjusting the clutching pres-sure as well as compensating for wear.



ELECTROMAGNETIC CLUTCH

This modification of the manual friction clutch provides remote control of the unit by means of solenoid actuation.



TORQUE RELEASE ASSEMBLY TYPE "A"

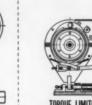
A mechanical attachment— integral with reaction arm— which provides complete dis-engagement when a pre-selected torque is exceeded.



TYPE "B"

TORQUE RELEASE

A mechanical at-tachment—sep-arately mount-ed—which pro-vides complete disengagement when a prese-lected torque is exceeded.



TORQUE LIMITING CLUTCH

Mechanical modification of the electromagnetic clutch assembly to provide auto-matic disengagement when a preselected load is exceeded.



DIRECT MESH ATTACHMENT

Permits 2-speed operation through a manually operated clutch mounted on reaction hub.



Engineered Equipment for Aircraft and Industry

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For complete information, write for Catalog IR-61 or contact our nearest office

RCA uses 252 CLARE Printed Circuit Relays in the 501 electronic data processing system

RCA's 501 incorporates many advanced features which significantly increase reliability as well as economy. It takes up less space, weighs less and operates on less electrical power than previous models.

252 relays (each consisting of 12 Clareed sealed contact reed switches—3,024 switches in all) make up this "matrix relay," used in the model 547.6 switching rule of the RCA 501.



CLAREED Sealed Contact Relays provide fast, sure switching

Contributing to the efficiency, speed and compact structure of the RCA 501 are 252 CLAREED sealed contact reed relays. Mounted on printed circuit boards, these relays, their contacts hermetically sealed in contaminant-free inert gas, assure millions of perfect operations...hundreds of millions when operated at up to ½ rated load.

CLAREED relays are ideal components for transistor-drive applications such as the RCA 501. Their low inductance, and the low

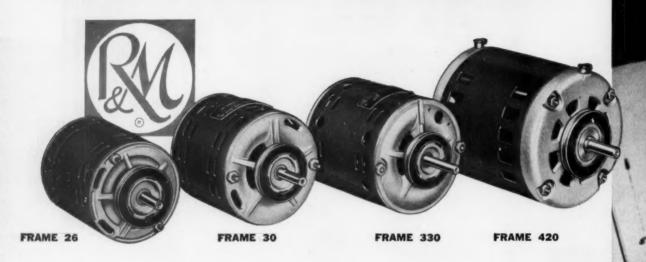
inductance change in the operating coil at each operation, limit the transients produced.

These relays may be mounted to meet the requirements of almost any application or environment. Consult your nearby CLARE sales engineer...or write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. Cable Address: CLARELAY, Ask for Bulletin CPC-10.

CLAREED switch capsule consists of a pair of magnetically operated contacts, hermetically sealed in an atmosphere of inert gas.



YOU CAN SEE THE EXTRA DEPENDABILITY BUILT INTO R&M FRACTIONALS!



new broad line offers ratings from 1/100 through 1/3 hp!

R&M's Special Application AC Motors feature extra dependability for your customers and offer wide design flexibility to you! Silent operation, compact size and minimum maintenance make these FHP motors ideal for powering office appliances, fans and blowers, small motor driven tools and countless other products. You can select from four frame sizes, 3" through 4¾" dia.; sixteen ratings from 1/100 through ½ HP; two, four and six pole speeds; three mounting arrangements; and four electrical types—capacitor start induction run, split phase, permanent split capacitor or polyphase.

For long-life operation, Mylar is used to line the burr-free slot cells. Mylar has 8 times the dielectric strength of conventional insulation and stubbornly resists tearing and aging, to provide virtually permanent protection. Venturi baffles in each end head direct fandriven air over and around coil ends in a "washing" action that quickly carries off heat, keeping the motor well within its rated temperature rise. The absence of centrifugal mechanisms and brushes further minimizes maintenance problems.

R&M Special Application Motors are available in standard off-the-shelf designs. Should you require a special custom motor, R&M will recommend the optimum design, at no obligation. Write today for new R&M bulletin 445-MD

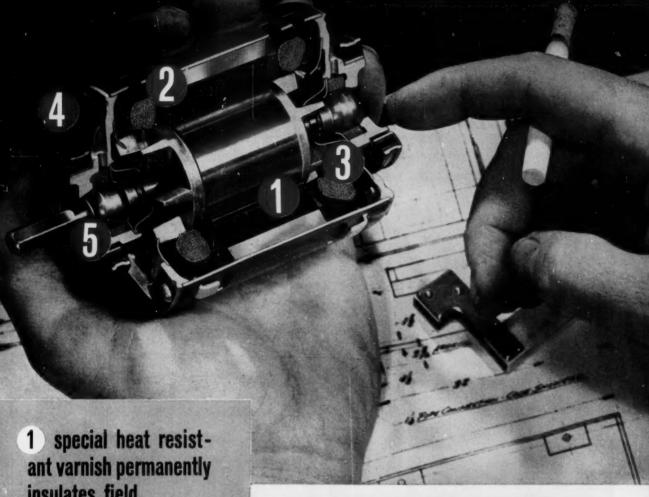
ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors * Electric Hoists and Overhead Traveling Cranes * Moyno Industrial Pumps
Propellair Industrial Fans * R & M-Hunter Fans and Electric Heat * Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.



FRACTIONAL MOTORS

special application



- insulates field.
- 2 Mylar* insulation locked in burr-free slots.
- 3 high velocity air flow cools motor windings.
- 4 lightweight, die-cast aluminum end heads.
- 5 choice of sleeve or ball bearings.





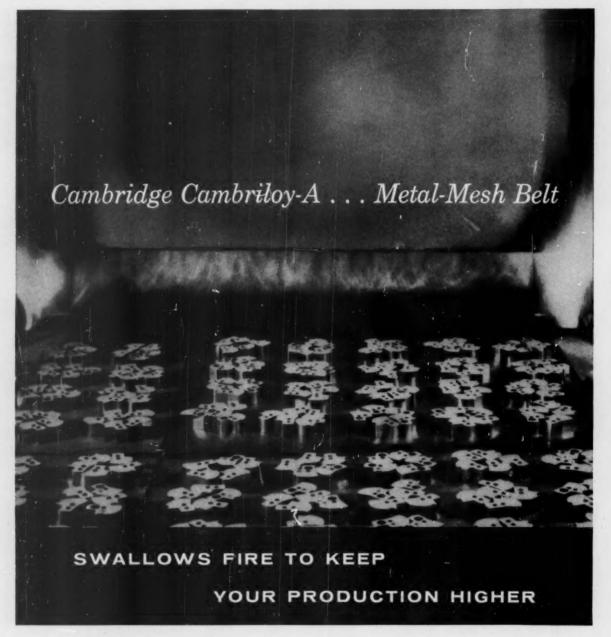
mounting styles



rigid base mounting



resilient base mounting



2100° F. sintering temperatures are no place for weakling belts. That's why so many sintering installations select Cambridge Belts made of Cambriloy-A alloy. They are specifically designed for high strength in high temperatures and resistance to murderous furnace oxidation atmospheres . . . built to give continuous month after month service and peak production with little or no maintenance.

There is a complete line of Cambridge Belts in special and standard metals and alloys to meet your specific requirements—custom built in any one of nine basic weaves to insure the most efficient processing.

Experienced Cambridge Field Engineers—experts in their field—are available to discuss your needs and

help you select the belt best suited to your operations. Or, they can offer you sound advice on the installation,

operation and maintenance of your Cambridge Belts. Talk to your Cambridge man soon. He's listed in the Yellow Pages under "Belting, Mechanical". Or, write for free 130-page reference manual.





The Cambridge Wire Cloth Co.

Department N . Cambridge 5, Md.

Manufacturers of Metal-Mesh Conveyor Belts, Flat Wire Conveyor Belts, Wire Cloth, Wire Cloth Fabrications, Gripper ® Metal-Mesh Slings

P-e-e-l-i-n-g down

perfect fit

Just a twist of a pen knife when your shims are made of LAMINUM® and you have a perfect fit—right on the assembly line. No machining. No grinding. No counting. No stacking. No miking. No costly stand-by equipment.

LAMINUM is the registered trade name for laminated shim stock that looks and acts like solid metal. Plastic or metallic bonded, the laminations p-e-e-l off easily to give you a perfect fit—right to a thousandth—right on the job.

Custom-made to your own blueprint specifications—in any quantity—shims of LAMINUM are produced exactly for your job. In brass...mild steel...stainless...aluminum...laminations of .002" or .003". You name it! You specify it! You have it!

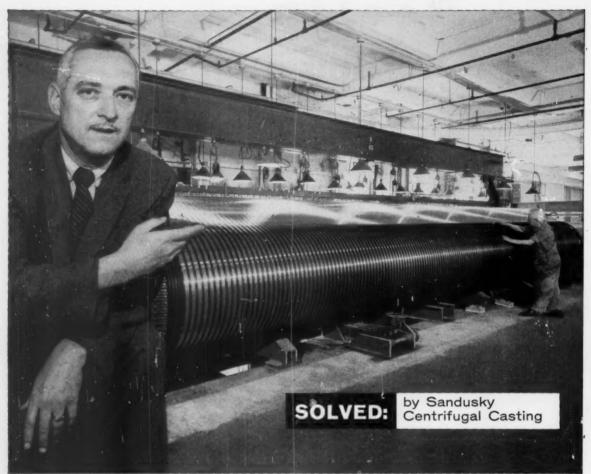
Find out how LAMINUM can save you time and money on your assemblies. Just write for revised SHIM DESIGN FOLDER No. 4 for complete, up-to-the-minute engineering data.

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THE LAMINATED SHIM COMPANY, INC.

West Coast Sales and Service - 600 Sixteenth St., Oakland, Calif. Home Office and Plant - 1205 Union St., Glenbrook, Conn.

Circle 294 on Page 19



Eastwood-Nealley's chief engineer points out great size of grooved cylinder

Who else could cast this 22-ton cylinder for the world's biggest wire cloth loom?

To weave Fourdrinier wires up to 352" wide for the world's newest and largest paper machines, Eastwood-Nealley Corp., Belleville, New Jersey, required a cylinder over 30 feet long.

Sandusky supplied this 44.685 lb. roll, centrifugally cast of SAE-1030 steel and rough machined to 363" in length, 40%" on the O.D., to be used as the backbeam on Eastwood's new wire cloth loom. Since the cylinder had to be machined with 176 extremely smooth 2" x 2" stirs (grooves) in which wire is wound, it had to be of flawless quality. Otherwise any voids or inclusions exposed by machining would nick the delicate bronze strands and cause the expensive wire cloth to fail.

Eastwood-Nealley's chief engineer, Clemson A.

Bower, asserts: "We chose a Sandusky Centrifugal Casting because only Sandusky could make such a gigantic cylinder without welding. We were confident that our special machining operation would be accomplished without costly re-makes, for in the 12 years we have been using them, we never found a single flaw in a Sandusky Centrifugal Casting!"

When cylinders or piping are needed in your design, keep Sandusky Centrifugal Castings in mind. We can supply cylindrical products from 7" to 54" O.D. and up to 33 feet long—made from a variety of alloys including stainless, carbon and low-alloy steels as well as copper- and nickel-base alloys. Send for free booklet, "Your Solution to Cylindrical Problems."



SANDUSKY, OHIO Stainless, Carbon, Low-Alloy Steels-Full Range Copper-Base, Nickel-Base Alloys



RULLETIN 712 Size 1 combination starter with fused disconnect switch



BULLETIN 713 Size 1 combination starter with circuit breaker



BULLETIN 705 Size 2 across-the-line reversing starter with overload relays



Size 1 reversing starter with fused disconnect switch



BULLETIN 715 Size 1 across-the-line, multi-speed starter with overload relays



Size 2 multi-speed starter with circuit breaker



BULLETIN 702 Size 3 three-pole, a-c



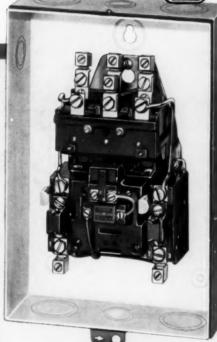
Pygmies in Size Giants in Performance-

the NEW Allen-Bradley Across-the-Line Starters!

This new line of across-the-line motor starters is the result of over 30 years of experience and leadership in the motor control field.

While retaining the simple solenoid principle-with only ONE moving part-these starters are completely new in every way. They are amazingly small in size-yet test after test has proved they will not only outperform but also outlast any starter now on the market. They are good for many millions of trouble free operations. All have scores of design refinements that make them easier to install and maintain. All are available in the smart new enclosures designed by Brooks Stevens. They make a beautiful addition to any machine or control installation.

You'll want to get the complete story about these truly revolutionary new across-the-line starters. Write for new Publication 6100.



BULLETIN 709

This popular across-the-line solenoid starter shows the new Size 2 construction. Note the white interior and generous wiring space. Bulletin 709 starters are available, in the new construction, in seven sizes-Sizes 00 to 5, with a maximum rating of 100 hp, 220 v; 200 hp, 440-550 v.

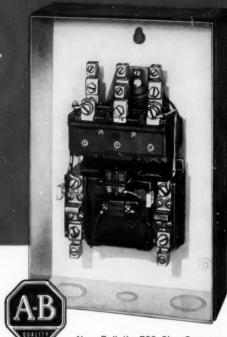
ALLEN-BRADLEY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

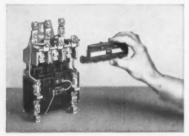
QUALITY MOTOR CONTROL

Features of the NEW Allen-Bradley starter line that are of value to you!

Every detail of the new Allen-Bradley motor starters has been designed to help make this the best line of motor control on the market. Remarkably small in size, each starter is a giant in performance. Being light in weight, these starters are easy to handle and a cinch to install. The generous wiring space, full front wiring, white interiors, and convenient knockouts make installation easy. The enclosure cover is firmly held with a quarter-turn fastener. All installation, inspection, and maintenance operations can be handled from the front—as shown in the illustrations below—without the use of special tools.



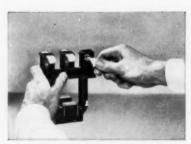
New Bulletin 709 Size 3 acrossthe-line motor starter. Note the generous space for wiring, accessible terminals, and white interior.



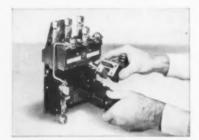
QUICK, EASY CONTACT INSPECTION— When the arc hood front cover is removed by loosening two captive screws, contacts are plainly visible from the front.



CONTACT POSITION INDICATED—Two slots in the coil cover show the position of the movable contact support—tell whether contacts are "closed" or "open."



CONTACTS EASILY REPLACED—Depress the spring slightly, and the movable contacts can be lifted out of the molded support and the new contacts slipped in.



COIL EASILY CHANGED—When the coil cover is removed, coil and magnet yoke can be lifted out from the front. They are impossible to replace incorrectly.



AUXILIARY CONTACTS EASILY ADDED to the front of the starter. Two extra auxiliaries can be added to Sizes 0, 1, and 2 starters, and four, to Sizes 3, 4, and 5.



A THIRD OVERLOAD RELAY CAN BE EASILY ADDED in the field, from the front of the starter. And the only tool needed is a common screwdriver.

ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

QUALITY MOTOR CONTROL



Said J. Stefan and L. Boltzmann: "The total radiation from a black body is proportional to the fourth power of the absolute temperature of the black body."

Radiation is usually associated with high temperatures. Yet very cold bodies emit a radiation which can be highly significant in missile and space applications. The problem faced by infrared scientists, trying to detect variations in radiation from low temperature atmospheres, can be likened to detecting a one-foot cube of ice from a distance of five miles.

Lockheed Missiles and Space Division scientists are deeply engaged in studying the problems of infrared emission from the earth and its atmosphere, as seen from orbital altitudes. Although the earth resembles a black body at 300° Kelvin, the emission from its atmosphere, under some circumstances, is much colder. To make measurements under these circumstances, Lockheed has evolved radiometric equipment with one of the most sensitive detection systems yet conceived.

Scientists and engineers must also take careful measurements of a potential employer. Lockheed Missiles and Space Division in Sunnyvale and Palo Alto, California, on the beautiful San Francisco Peninsula, invites this close scrutiny. As Systems Manager for the DISCOVERER and MIDAS satellites and the POLARIS FBM, Lockheed preeminence in Missiles and Space creates positions in many disciplines for outstanding engineers and scientists.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-13F, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Lockheed | MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs
SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

if you use TORQUE MOTORS

... the name is

The torque motor, unlike any other electric motor, is a special from the word go. That situation alone makes Peerless one of the best sources for torque motors in ratings from 2 oz. in. to 200 lb. ft.

Torque motors deliver maximum rated torque without damage to the windings when stalled across the line at full voltage for predetermined periods. Peerless also builds torque motors which provide a nearly constant torque while operating at less than synchronous speeds.

All standard frame sizes; all types of mountings; high torques; special paint and varnish treatments; and Class A, B and H insulation are available from Peerless. Torque motors require unusually close cooperation between the motor supplier and the customer's engineers. This cooperation is a Peerless specialty. We will work with you to produce the one torque motor that powers your product best.



ther-Tight Special Flange



Explosion-Proof Torque Motor with Brake



Special Flange Reversing Hoist Motor Single Phase

Comparative Speed-Torque Curves of NEMA Design B Motor and Typical Torque Motor SPEED DESIGN B MOTOR SYNCHRONOUS TORQUE MOTOR 9 % OF LOCKED TORQUE

The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.

NEW TORQUE BULLETIN-This bulletin outlines basic facts about Peerless torque motors and shows applications. It is available FREE.

Write for it today.

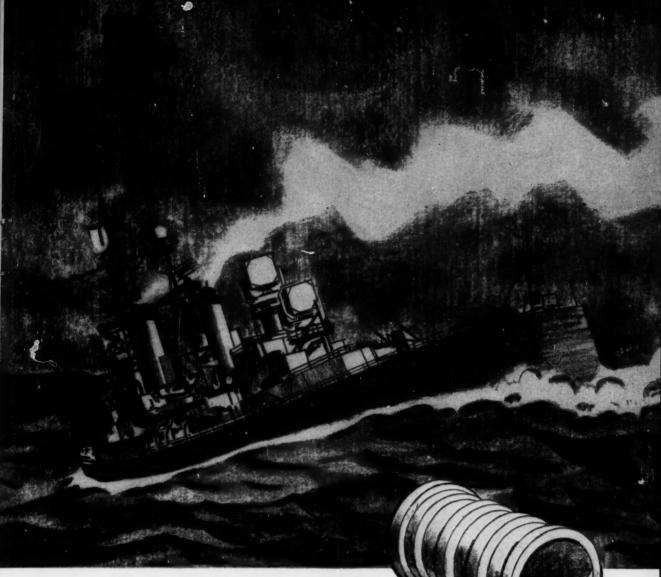
Peerless Electric Division, H. K. Porter Company, Inc., Warren, Ohio

PEERLESS ELECTRIC DIVISION



H.K.PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.



When cylindrical parts are vital it pays to specify Shenango Centrifugal Castings

The stern tube bushing for a fast new Naval vessel illustrated here is one good example of the critical engine parts which are centrifugally cast in Shenango's big foundry and precisely finished in its extensive machine shops. Ferrous or non-ferrous sleeves, bearings, rings or rolls are cleaner, denser and more uniform when they are cast by spinning and they enjoy longer life. And because of Shenango's large capacity and experienced staff your biggest and most complex orders will be handled quickly and exactly to specification. Write for literature.

CENTRIFUGAL CASTING DIVISION

FURNACE COMPANY

DOVER, OHIO

THIS IS SHENANGO!







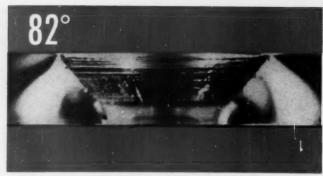
centrifugal castin



Copper, Tin, Lead, Zinc Bronzes • Aluminum and Manganese Bronzes • Monei Metal • Ni-Resist • Meehanite Metal • Ductile Iron Circle 298 on Page 19

PQA* proves it...

this Allen
Flat Head
Cap Screw has
complete
all-around
head contact



PQA makes it certain that an Allen Flat Head Cap Screw has contact throughout the angle of the head with the mating countersunk hole. This assures the strongest possible fastening. In this photo, made with polarized light, you can see the stress points throughout the chamfer.



Industry standards allow a tolerance of $+2^{\circ}$ in the head angle. Allen Flat Heads manufactured to this tolerance have greater bearing at the top of the head—shown by the stress patterns in this polarized light photograph.

*PRODUCT QUALITY ASSURANCE

ALLEN

MANUFACTURING COMPANY HARTFORD 1, CONNECTICUT, U.S.A.

Plant at Bloomfield, Connecticut
Warehouses in Chicago, Cleveland and Los Angeles

Genuine ALLEN products are available only through your ALLEN Distributor. He maintains complete stocks close by to help cut your freight costs, inventory, warehousing and handling. He offers fast, single-source service. He knows ALLEN products. And he makes ALLEN Engineering Service available to you any time. Call bin!



82° -2°

Industry also allows a tolerance of -2° in the head angle. But Allen does not utilize this negative tolerance. The reason—it is entirely possible to have head seating efficiency reduced because of excessive interference in the head-shank area. The photo shows high bearing stress in this area—with risk of breaking prematurely.

PRODUCT QUALITY ASSURANCE is the symbol of unquestioned quality at ALLEN. It stands for constant quality control every step of the way—your guarantee of quality and reliability.





We whirl Federal Ball Bearings at different speeds-and we listen. Seasoned Audio Inspectors and sensitive Anderometers police our production lines, on the alert to intercept anything but the quiet. They monitor our radial, angular contact and thrust bearings. Also, our self-aligning and shafted types. Single and double row, open and sealed. Result: bearings that purr on the job. Never a growl out of them. Just one reason why so much of industry turns on Federal Ball Bearings. Want more reasons? Send for our catalog. It describes hundreds of types in all sizes. The Federal Bearings Co., Inc., Poughkeepsie, New York.







connector GIVES YOU BOTH

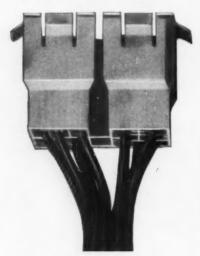


economical assembly, WITH ALL 3



AMP-LOK®

- self-locking friction contacts create positive wiping action
- · low millivolt drop
- . 3, 4, 6, 9 and 12 circuits
- wire ranges #22-#18, #20-#15
 and #18-#16 AWG
- nylon housing has "snap-in" wings for through panel use
- keying plug prevents mismatching caps in side-by-side mounting



AMPEEZ

- 7, 14 and 20 circuit
- insertion/extraction force of 2-5 lbs. per contact
- "Tab-Gap Lok" prevents contact spread
- fits wire size range #18-#14 AWG
- amperage rating 20-25
- nylon housing polarized for perfect mating
- mounts flush—only .125" projects from panel front



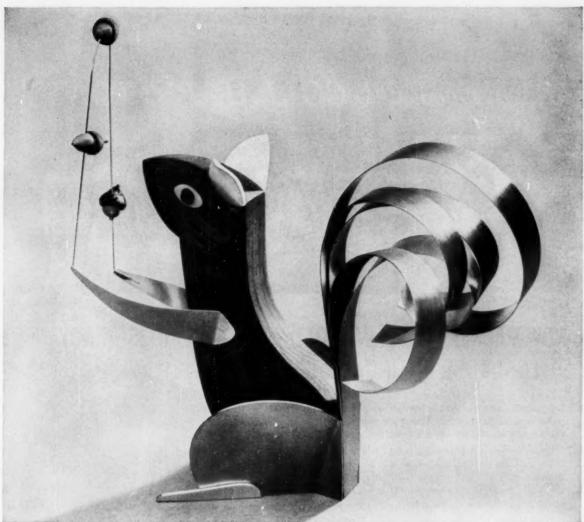
FASTIN-FASTON

- 1, 2, 6 and 8 circuits
- · contacts are self-locking in housing
- · fully tested for millivolt drop
- nylon or cycolac housings polarized to prevent circuit errors
- wire insulation support for vibration resistance
- full wire size #18-#14 AWG
- * Trademark

This line of AMPin-cert Connectors gives you minimum insertion and withdrawal forces, maximum amperage ratings, resistance to vibration, corrosion and environmental factors . . . everything to assure lower assembly costs, rugged performance and simplified maintenance. Check these features and see how they fit your design plans. Any additional information you may need will be sent on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA



Original sculpture created for 3M Co. by Guy Palazzola

THRIFT

... Save three ways fabricating with 3M Adhesives!

When a switch from brazing to adhesive bonding saves a timer manufacturer \$56.37 per thousand . . . when adhesives replace rivets and cut assembly costs 25% for a maker of metal containers . . . when a new structural adhesive cuts pump assembly rejections to nearly zero . . . can you afford not to look into the cost revolution being worked by modern 3M Adhesives?

Save time, money, materials! 3M Adhesives eliminate hole-making, countersinking, heat-treating. They bond without impairing integrity of structural members. No nuts, bolts, rivets, staples, welding, brazing. Metal thickness, joint size are reduced. One operation bonds and seals. Quality bonuses: bond strength exceeding materials bonded, smoother contours, improved fatigue resistance.

You can bond any material to itself or another, with 3M Adhesives. Item: tool manufacturer stopped costly machining of motor end plates from solid bronze, by adhering powdered iron discs to aluminum castings. Results: lower machining costs, increased strength and portability.

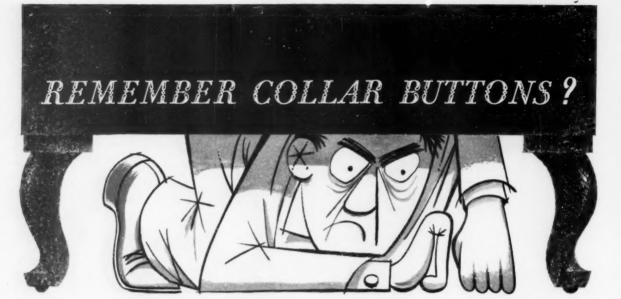
Why not? Let 3M Adhesives help you save on production! For a realistic analysis of the cost-cutting possibilities inherent in your operation, call your nearest 3M Field Engineer or write: AC&S Division, 3M Company, Dept. SBR-51, St. Paul 6, Minn.

"SCOTCH-WELD" is a Reg. T. M. of 3M Co. © 3M Co., 1961

What do you want to bond to what? The 3M Squirrel is fabricated of these maturals and bonded with 3M Adhesives, including "Scotch-wELD"® Brand Structural Adhesives: 1. Wood 2. Plastic 3. Aluminum 4. Stainless Steel 5. Copper 6. Brass 7. Glass

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY



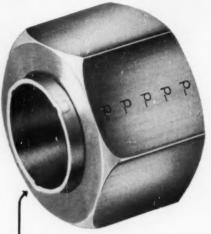
NOW **PARKER** HAS ELIMINATED A MORE SERIOUS ANNOYANCE ... LOST TUBE FITTING FERRULES!

A simple change in the design of Parker "Intru-lok®," the positive, bite-type Parker fitting for copper, aluminum or plastic tubing, has solved an age-old problem.

Small three- and four-piece tube fittings have long been a pain in the neck on applications where it is necessary to remove the nut from the fitting. The ferrule(s) fall out and promptly disappear. If and when found, they often get put in backwards. Sometimes they never get put back at all. Result, in either case: a leaking joint.

Now Parker has developed a snap-in, captive ferrule for "Intrulok." You can take it out of the nut, "on purpose," but you can't drop it out accidentally.

You get all the leakproof safety of a three-piece fitting with positive "bite." You also get the convenience, the quick, easy assembly of a two-piece fitting. The easiest fitting to install has been made even easier. Write for new "Intru-lok" dimensions and prices today.



Three "detents" hold the "tail" of the new ferrule in the nut. Also, the larger hole in the nut makes tube bends closer to the fitting possible. Note the larger wrench flats on this huskier nut. too.







When



the Bird's on the wing

SAGINAW b/b SCREW HELPS INTEGRATE TIME AND DISTANCE FROM 2 TO 50 G's

BALL NUT

RESET PROMISE

RESET MECHANISM

Courtesy Integrated Dynamics Div., Globe Industries, Inc.

WRITE FOR OUR NEW DATA BOOK OR SEE SWEETS DESIGN FILE Saginaw Ball Bearing Screws are highly efficient whether they are driving or being driven. A unique example is the way Integrated Dynamics Division, Globe Industries, Inc., Albuquerque, New Mexico, uses a b/b Screw.

First, the design problem: Develop a time-delay switching device which integrates the time function with missile's linear travel. The purpose is to safely arm the warhead. A strict "minimum G—time" system may arm a slow bird too soon for adequate protection of our own forces . . . and a fast missile may arrive before the warhead is fused.

Integrated Dynamics developed and builds the mechanical distance switch shown in the functional drawing to the left. The high-efficiency Saginaw b/b Screw is used to convert linear acceleration force into torque. Essentially proportional to the G-force, the torque of the b/b Screw is used to drive the flywheel mass. Flywheel energy, in turn, is used to actuate the arming switch through a cam.

The time required by the ball nut of the Saginaw b/b Screw to travel the length of the screw is also almost directly proportional to applied G-force. Thus, missile travel in distance is effectively integrated into a time delay which arms the warhead within a \pm 5% of the desired distance on accelerations between 2 and 50 G's.

The Saginaw b/b Screw runs dry — without lubricants — in this application. Using the same b/b Screw, the switch gives repeatable distance accuracy of one percent. The screw is ground and electropolished to a surface finish of less than 5 microinches. The balls used are only one millimeter in diameter.

Whatever your actuation problem, chances are you can use a Saginaw b/b Screw to do the job efficiently. Why not write Saginaw b/b Screw and Spline Operation, Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Michigan.

Saginaw



WITH 2,000 STANDARD UNITS AVAILABLE PUROLATOR HAS THE RIGHT FILTER FOR EVERY FILTRATION APPLICATION

The narrow tolerances and precisely-machined parts found in today's equipment demand proper filtration for maximum output and long life. In fact, filtration has become a basic tool of the product designer. Shown are just four areas in which standard Purolator filters can result in improved design...better performance...reduced wear. Purolator is the world's most experienced manufacturer of filters. Whatever kind of filtration your design calls for, chances are standard Purolator filters will do the job. Consult your nearest Purolator office. Or, if yours is a specialized application, we'll design—and build—a filter to fill your needs. Write: Purolator Products, Inc., Rahway, New Jersey.

1. AIR INTAKE FILTRATION. Purolator dry air filtration positively prevents all contaminates from entering engine. After becoming clogged with dirt, conventional oil bath filters continue to let damaging, dust-laden air into the engine. On the other hand, a dry type filter like a Purolator Micronic® unit positively filters all air entering the



engine. Purolator's new 2-stage filter continues to remove 99.98% of all contaminates even if one filter element should be out of

Replacing a Micronic® filter element is easy too. Takes less than a minute. And since there is no oil to spill... no oil level to maintain... the filter can be installed anywhere on the engine.

2. LUBRICATING OIL FILTRATION. Purolator's "selective"
filtration leaves additives in heavy-duty or detergent oils.
Improper filtering of lubricating oils can also remove costly, engine-protecting additives.

3. GASOLINE ENGINE FUEL FILTRATION. Compact Purolator
GF-11 Series fuel filter is adaptable to many gasoline engines.

Controlled porosity of the Micronic® element of a Purolator lubricating oil filter removes particles of dirt measured in microns



(.000039-inch). Yet, it never removes needed additives. These Micronic® elements are unaffected by high temperatures or water. Never develop soft spots—or channel.

What's more—a Purolator Micronic® filter of correct size can handle full lubricating oil flow for even the largest engines. This eliminates the need for partial flow systems—whereby many harmful contaminates can remain in the lubricating system.

3. GASOLINE ENGINE FUEL FILTRATION. Compact Purolator GF-11 Series fuel filter is adaptable to many gasoline engines. Particles of dirt as small as 10 microns in the fuel system can choke and stall a gasoline engine. Carburetors like the modern 4-barreled units especially need positive filtration for efficient operation.



Purlator's GF-11 Micronic fuel filter is especially designed for the job. Used on many 1961 cars, it can be incorporated equally well into the fuel system of many gasoline engines.

Measuring only 3" x 1%", it can be easily installed either horizontally or vertically. Fully 70 square inches of filtering surface removes all contaminates down to 5 microns. Filter is designed as a throw-away unit... good for over 5,000 miles of operation.

4. DIESEL FUEL AND LUBE OIL FILTRATION. Series G-144J metal edge filters offer permanent, uninterrupted filtration for fuel and lube oils. Standard equipment on many of the largest, most modern diesel engines, the G-144J filter requires an absolute minimum of maintenance.



Made of precisely-spaced metal ribbon wound in cylinder form, the filter element lasts indefinitely. Cleans by an occasional twist of the hand wheel on top of the unit which rotates the filter element against a fixed knife blade. No need to cut off the engine or to interrupt the flow of fuel.

Spacing of ribbon determines degree of filtration—which ranges from 25 to 500 microns. Fine filtration is recommended for fuels. Less fine filtration for lube oils.

Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, CANADA



test <u>every</u> valve?

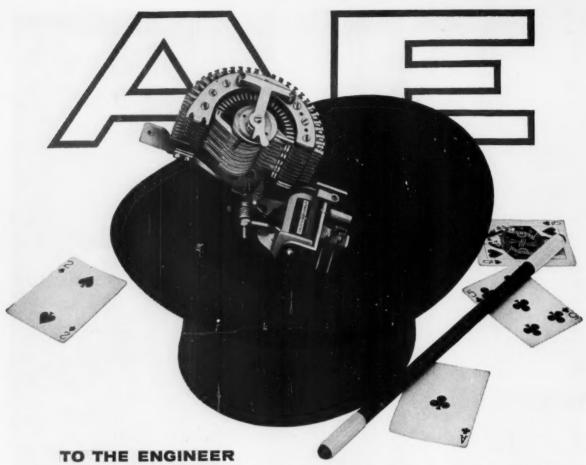
Valvair does! How else can any manufacturer be sure that every valve he ships to a customer will function properly, from the first cycle on?

Each Valvair valve is cycled and re-cycled under water, at 30 to 50% above its rated pressure, to be certain that it meets Valvair's rigorous performance specifications. And, this final operating test is just one of the countless rigid quality control inspections each part of every valve must pass during its manufacture. In fact, one out of every twelve Valvair production men is a full-time inspector. Parts are scrutinized in process, as well as just prior to assembly. The most modern types of equipment, including optical comparators, surface finish indicators, optical and air gaging units, super magnifiers and precision gages, are used by the inspection team to assure Valvair's reputation for outstanding quality.

Specify Valvair components for the equipment you design, build or operate, to maintain your reputation for quality. For all the facts, write for Bulletin 59-SK, or call your nearby Bellows-Valvair Field Office. Address Bellows-Valvair, Akron 9, Ohio, Dept. MD-561.



DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)



who can use a little honest trickery

There's more than one way of skinning a cat -or making ideas work automatically. And AE has a bag-full.

That's because AE has had years of experience in making relays and stepping switches work wonders in automatic telephone exchanges-and in automatic control devices.

If you can use some down-to-earth magic in your designs, AE engineers will be glad to help. And you may well find that their suggestions can simplify the control package.

They can also show you why AE relays and stepping switches cost you less in the long

For instance, the AE Type 45 Stepping Switch, illustrated, has a free-floating pawl that never binds, never breaks, eliminates the necessity of ever readjusting armature stroke, does away with doublestepping or overthrow. And the switch usually outlasts the equipment it's built

You'll also be interested in knowing that AE is equipped to deliver completely wired and assembled control units designed to your specifications.

If you need timed impulses at equal or unequal time intervals, accurately spaced, send for more information on these highspeed, multi-contact rotary stepping switches. Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Ask for Circular 1698-J.





automatic electric

GENERAL TELEPHONE & ELECTRONICS





HYDRECO

out front in . . .

PRODUCTION QUALITY CONTROL

JUST ONE MORE WAY HYDRECO SERVES YOU BETTER!

Modern gaging equipment — like these units for checking critical dimensions
— is an important factor in the reliable quality control provided by Hydreco.

Such equipment is used at every stage of the manufacturing process.

But Hydreco quality control does not stop there. To insure precision made products, master gages are also used to double check the accuracy of production gages!

This gaging equipment is just one more reason why Hydreco continues to lead in the essential areas of quality and performance. It's also one of the big reasons why — when it comes to Hydraulic equipment — more and more companies are switching to Hydreco . . . the one that serves you best.

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY







VA

MOTORS





Wind Velocities to Mach 7 Prove Needle-Size Superior Stainless Tubing

Manometer lines of Superior Type 304 stainless tubing, drawn to needle size, withstand the vibration caused by air speeds beyond Mach 7 and internal pressures as high as 5000 psi in FluiDyne wind-tunnel tests of missile component models. And they have been in some assemblies for $3\frac{1}{2}$ years without cracking, pinholing or buckling.

FluiDyne Engineering Corp., one of the major designers of such test facilities, attributes the long life of this Superior tubing to both its high modulus of elasticity and its resistance to the corrosive effects of mercury and soldering-flux acid.

Ductility is a big advantage, too. This permits the Superior tubing to be easily hand-bent into complex shapes for application in wind tunnels and readout equipment.

Filling stainless steel tubing orders that call for tiny needle tubing in gages from 6 to 33 or tubing with OD's as large as 1.125 in. calls for the resources Superior has to offer. Why not investigate us as a source of small-diameter stainless tubing. Catalog 21 describes the types and analyses available. Also gives tips on its selection and application. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing NORRISTOWN, PA.

All analyses .010 in. to \% in. OD-certain analyses in light walls up to 21/2 in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST



Faultless manufactures over 10,000 caster types, sizes, and varieties... casters for every conceivable purpose... The Casters to move your products easily, in quantity, economically! Faultless Casters are engineered and tested to roll smoothly and efficiently under any load from 15 lbs. to 15,000 lbs. per caster. And Faultless manufactures a complete selection of swivel, rigid, plate, and stem casters, plus a wide variety of special application casters. This complete selection from one manufacturer—Faultless Caster Corporation—includes The Casters to reduce materials handling costs and increase efficiency at your plant.

Your Faultless Industrial
Distributor, or your local
Faultless Sales Engineer can
supply you with detailed
information on the complete Faultless Caster line.
Also, your Faultless Distributor maintains a substantial stock of Casters
for immediate shipment.



Faultless Caster Corporation EVANSVILLE 7, INDIANA

Branch Offices in principal cities of the U.S.; see the Yellow Pages of the telephone book under "Casters." Canada: Stratford, Ontario

ORANGE ROLLER BEARINGS





Wide choice of Types and Sizes enables you to

MATCH THE BEARING TO THE JOB

for maximum load capacity — speeds
— life expectancy — and economy

ORANGE Cage Type NEEDLE BEARINGS

Precision needle rollers are permanently aligned in pockets of anti-friction cage—resist skewing while running in vertical, tilted or horizontal position. Successful on overhung mountings; less affected by misaligned mountings or shaft deflections. Sizes, without seals, ½" to 8" shaft dia.; with built-in seals, ½" to 2" shaft dia.



ORANGE ROLLER BUSHINGS

Full type precision needle bearings provide maximum load capacity in small radial space. Close internal running clearances minimize possibility of misaligned rollers. Standard sizes 3/2" to 8" shaft dia.



ORANGE STAGGERED ROLLER BEARINGS

Exceptionally high load capacity and even running are gained by use of many short rollers in staggered arrangement, instead of fewer long rollers. All standard, interchangeable sizes in the 200 and 300 series.



ORANGE CAM FOLLOWERS

Provide high load capacity and shock resistance. Standard sizes from ½" to 4" O. D. with either standard or heavyduty studs. Chrome, Cadmium or Black Oxide finishes available; also seals where required.



ORANGE JOURNAL ROLLER BEARINGS

Provide high load capacity where radial space is limited. Available as complete bearings or as component parts in inch sizes, in multiple lengths, 5%" to 5" shaft dia.



ORANGE CAM YOKE ROLLERS

For yoke mountings involving follower action, and for machine elements requiring guide or support rollers. Standard sizes from ¾4" to 4" O. D. Chrome, Cadmium or Black Oxide finishes available; also seals where required.



ORANGE THRUST ROLLER BEARINGS

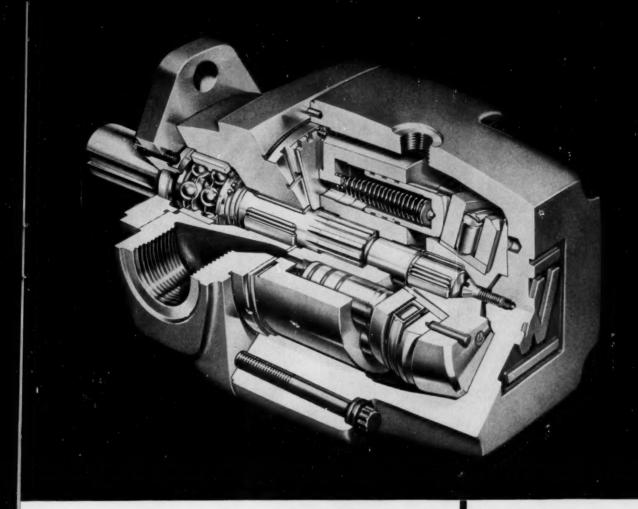
Cylindrical roller type thrust bearings provide high capacity and durable service. Available in light series ½" to 16" bore; heavy series from 2" to 16" bore. Special types and sizes to order.



See the complete line on display— BOOTH 1020 DESIGN ENGINEERING SHOW

ORANGE ROLLER BEARING CO., Inc. 556 Main Street, Orange, N. J. Send for 48-page Engineering Reference Manual showing dimensions, capacities, Installation data on all Orange Roller Bearings.





WEBSTER'S NEW C3F PISTON MOTOR AND PUMP

compact, simple design **a** exceptionally serviceable!

This new hydraulic power unit — developed especially for the machine tool field - features unique application and servicing advantages. Examples: (1) small "package" to fit in close quarters — SAE "A" size mounting can be used with easy access to both mounting holes; (2) simplest axial-type piston pump on the market — fewest parts, fewer potential trouble spots, greater economy; (3) easily serviced — all critical moving parts can be readily replaced in the field. Shaft can be exchanged by disassembling seal end only; (4) unit can be disassembled and the rotation reversed in the field - can be arranged for use as a dual rotation motor; (5) variety of mounting styles — mounting plate and seal assembly is a separate piece and can be furnished in several mounting styles; (6) drive shafts are available with keyways or splines.

The C3F Series can be used as a hydraulic motor (remote rotary locations, screw feeds - anywhere an electric motor might be used) or as a hydraulic pump. . wherever high torque and smooth, steady force are required. It is available in four sizes — from .72 to 1.81 cubic inches per revolution. Capacities range from 3.3 to 8.5 gpm at 1200 rpm; 7 to 18 gpm at 2400 rpm.

C3F SERIES

FIXED DISPLACEMENT AXIAL-TYPE PISTON MOTORS AND PUMPS

Drive: direct, gear or belt

Displacements: four sizes; .72, 1.09, 1.45, 1.81 cu. in. per rev.

Porting: Side ports - horizontal or vertical - handle 1" NPT inlet or 114" "O" ring straight thread

Capacity: 3.3 to 8.5 gpm at 1200 rpm 7 to 18 gpm at 2400 rpm

Pressures: continuous duty 3000 psi, intermittent rating to 3500

When used as motor:

Torque range (theoretical): four sizes; 11.52, 17.28, 23.04, 28.80 inch pounds per 100 psi

Output: 5.5 to 14 hp. at 3000 psi at 1200 rpm 11 to 28 hp. at 3000 psi at 2400 rpm

OIL HYDRAULICS DIVISION

WEBSTER W ELECTRIC



The peacock, they tell us, flaunts color to win attention. (From lady peacocks, we presume). You, too, can attract attention with color. But in a more businesslike way. With Ozalid Sensitized Papers you can color-code any engineering or business system. Speed and simplify paperwork. Eliminate routing errors. Make sure important or top secret documents get instant



action when needed. In engineering, for example, "blueprints" no longer need be blue. Office systems—production control, order-invoicing, income tax returns—can be coded by function, status, time or destination. Sales bulletins, charts, graphs, presentations can be brightened...made more effective by color. Want to simplify, error-proof your

office system? Show your colors! Our booklet "Color says so much . . . so much faster" tells you how. Send for it today. Ozalid, Dept. 212, Johnson City, N.Y.

OZALID WE REPEAT OZALID

Colored Papers speed communication, cut overhead. 12 eye-catching stocks for dry Ozalid and semi-dry Ozalax machines. Remember: for best results from Ozalid Whiteprinters use Ozalid Paper and Ozalid Supplies... we repeat; use Ozalid Paper and Ozalid Supplies...

DIVISION OF BENERAL ANILINE & FILM CORPORATION

NICKELOID IS EVERYWHERE









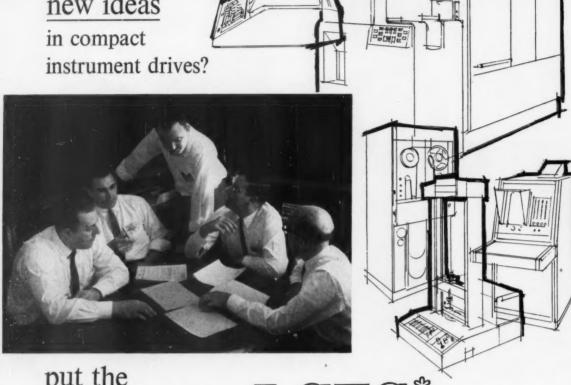




Yes, wherever you go or whatever you do, there is an abundance of useful and prized products on which a Nickeloid Metal gleams, front and center, in full spotlight. Their use at once captures a smart, modern beauty that is durable, easy to keep looking new, and chic. But here is beauty that is more than skin deep . . Nickeloid Metals are versatile, extremely economical in manufacture . . . deep-down in quality all the way. They are the shopkeeper's delight, the manufacturer's friend, and the designer's inspiration. You can do so much with Nickeloid! It's more than a Metal . . . it's . Method! Write for free Introductory Kis including metal a Method! Write for free Introductory Kit, including metal samples. Or, phone one of our sales offices (located in most DESIGN ENGINEERING SHOW (ROOTH #1042) COBO HALL, DETROIT, MICH., MAY 22-25. principal cities).

America's Pioneer Manufacturer of Pre-Finished Metals - Since 1898

looking for new ideas



put the WARNER ACES*

on your design team...but not on your payroll

Advanced Control Engineering Service

Call on an expert clutch and brake design team that doesn't cost you a penny! Warner ACES . . . Advanced Control Engineering Service . . . working closely with your design engineers, brings you the experience gained in the application of Warner fractional hp electric brakes and clutches to hundreds of low-torque drives for instant actuation, smooth inching and jogging, high-speed cycling, synchronization, and automatic indexing. If your motion control problem involves data processing equipment, business machines, computers, aircraft componentsalmost any automatic device that requires fast automatic electromagnetic braking and clutching in a compact, lightweight package, here is the answer: Warner fractional hp electric brakes and clutches plus the extra advantage of Warner ACES on your design team. Phone or write Warner today for further details!

Warner fractional hp electric brakes and clutches

provide high torque per size while controlling complex mechanical movements in limited space. Handling torque loads from 1.5 to 240 lb-in., these units are only

1" to 4" in diameter and just 7/8" to 2-1/2" long. For compact direct automatic actuation... investigate these versatile Warner electric brakes and clutches.



WARNER ELECTRIC

Warner Electric Brake & Clutch Co., Beloit, Wisconsin



...unusual features solve your cylinder problems

NEW HANNA Powrmation (CYLINDERS

Pressure Safe Tube Seals

on the outside diameter of the tube create the most positive seal possible at all pressures from zero to maximum.

Powrmation
Rectangular Flange
Rod End

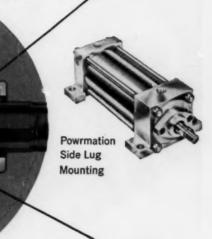
One Piece Steel Heads-

Welded Steel Mountings

for maximum strength, perfect alignment...superior to bolted assembly. Mountings carry maximum cylinder load with ample safety margin.

Fast Change Cartridge Gland

has leak-proof, low-friction rod seal and a rod wiper to remove dirt and to provide extra sealing.



of close-grained nodular iron with high graphitic content... one of the finest bearing materials. Rod seal on external side of bearing provides automatic bearing lubrication by hydraulic fluid or airborne lubricant.

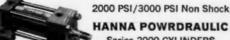
Long Lubricated Bearing

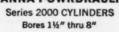
POWRMATION CYLINDERS FOR AIR TO 250 PSI • HYDRAULIC TO 1000 PSI • BORES: 11/2" THROUGH 14"

All good cylinders have "features" but few have a combination of really *Unusual* features that assure superior cylinder performance and dependability... New Hanna Powrmation Cylinders have. The features shown above and several others like: Unique, Check-Valve Cushions; Low Friction Nodular Iron Pistons; Posi-

tive Seal Block Vee Packings; Chrome Plated High Strength Steel Rod;—all these together with Hanna precision manufacturing and Hanna Field Engineering Service are the reasons why it will pay you to specify Powrmation Cylinders... they meet J.I.C. recommendations and have dimensional interchangeability.

For Top Performance in Hydraulic Pressures







Write for Catalog 1000

or phone your nearest Hanna Representative listed in Thomas' Directory; consult "Cylinders" in the phone book Yellow Pages; see our catalog in Sweet's Design File.

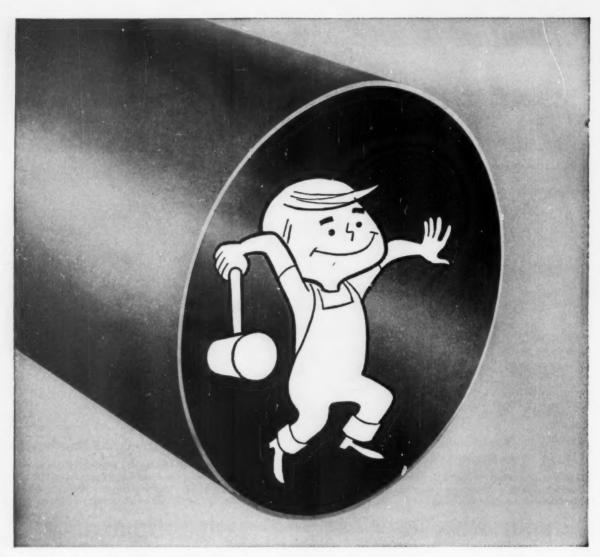




HYDRAULIC AND PNEUMATIC EQUIPMENT... CYLINDERS... VALVÆS

1751 Elston Avenue

Chicago 22, Illinois



"The Gravity Kid" shows why

CONTOUR-WELDED TUBING OFFERS GREATER FATIGUE STRENGTH, LONGER SERVICE LIFE

Tubing fatigue strength depends largely on how the tube is welded, and the results obtained. Tubing that's smooth inside — free of flaws and bulging weld beads — offers much greater fatigue strength and longer service life. Contour-welded* tubing is / L

Contour-welded* tubing is smoother inside than conventionally-welded tubing. It's smoother because it's welded at the bottom. Gravity pulls the metal down so that the weld corresponds to the tube's inside contour. There's no bulge on the inside sur-

face. Even on the outside, the seam closely conforms to the tubing shape.

Contour-welding provides greater strength than con-*U.S. Patent 2,716,692 ventional welding, because in conventional welding, gravity pulls the molten metal down into the tube. This can form a bead that is difficult to remove by cold working. And cold working can lead to deep, sharp undercuts that seriously weaken the tube.

Contour-welded tubing is smoother than seamless, too. That's because it's formed from uniformly rolled strip steel; whereas, seamless is produced by extruding or piercing. This strip is 100% inspected. So, there are no undetected tears or fissures inside.

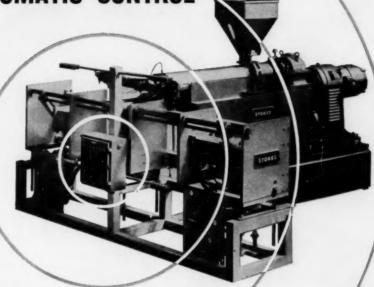
See for yourself why Contour-welded tubing offers greater fatigue strength, longer service life. Write today for our free 48-page manual which describes tubing sizes from 1/8" to 40" O.D., in stainless and high alloy steels, titanium, zirconium, zircalloy, and Hastelloy**.

TRENTWELD® Stainless and High Alloy Tubing

Trent Tube Company, a Subsidiary of Crucible Steel Company of America, General Offices and Mills: East Troy, Wisc.; Fullerton, Calif.

AN INDUSTRIAL TIMER

FOR AUTOMATIC CONTROL



At the heart of the new, high capacity STOKES BLOW MOLDER

The production of hollow plastic articles (containers, dispensers, etc.) has been boosted immeasurably with the development of "High Capacity Stokes Dual-Manifold Blow Molder".

And at the heart of the system is an Industrial Timer Corporation timing device to provide the precise control of each cycle of processing.

Wherever precise timing controls are required in industrial processes, or in equipment, Industrial Timer Corporation has the wide range of instruments, the wide experience in applying them, that assure the perfect answer to your problem.

If timing is of the essence . . . take the time to consult an Industrial Timer expert.

Phone or write us.



RUNNING TIME METERS



RECYCLING TIMERS



INTERVAL TIMERS



TIMER DELAY TIMERS



INDUSTRIAL TIMER CORPORATION

1404 McCarter Highway, Newark 4, New Jersey

Manufactured and sold in Canada by Canada: Sperry Gyroscope Ottawa Ltd., 3 Hamilton Ave., Ottawa, Cen. • PA 8-4681

Circle 317 on Page 19

how Lord can help improve performance

High-strength elastomeric mountings and joints are custom designed to control dynamic disturbances, reduce wear, accommodate relative motion . . . thereby upgrading performance, reliability, acceptance. These compact, easy-to-install units resist severe conditions, often outlast metal parts, never need lubrication.

DESIGN FOR SUPERIOR

PERFORMANCE

with Lord vibration/shock/noise control

on crawler tractors . . .

- Engine mountings isolate engine disturbances.
- Radiator mountings prevent fatigue failure.
- Instrument panel mountings improve instrument life and accuracy.
- Seat mountings enhance operator safety and comfort.
- Load equalizer joints absorb road shock, accommodate misalignment and relative motion.
- Diagonal brace pivot joints eliminate metal-to-metal contact and lubrication.
- Trailer hitch mountings absorb starting-stopping shock.

Crawler tractors can be designed for greater handling ease, lower maintenance requirements and longer component service life.

Lord-engineered vibration control is a proved route to this superior performance . . . and to the competitive edge it will give your product.

Suggested here are seven performance-improving ideas which should be considered early in the design of your next model. Utilizing rubber with a backbone of steel, Lord mountings cushion brutal jolts, isolate damaging vibration, "give" under frame distortion. As a result, your tractor rides easier and handles better, components last longer and need fewer repairs.

Lord engineers are ready to help you design for superior performance. Take advantage of Lord experience—contact your nearest Field Engineering Office or the Home Office, Erie, Pennsylvania.

See us at the Design Engineering Show - Booth 912, Cobo Hall



FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - CEdar 7-9247 BOSTON, MASS. - HAncock 6-9135 CHICAGO, ILL. - Michigan 2-6010 DALLAS, TEXAS - Riverside 1-3392 DAYTON, OHIO - BAIdwin 4-0351 DETROIT, MICH. - Diamond 1-4340 KANSAS CITY, MO. - WEStport 1-0138

LOS ANGELES, CAL. HOllywood 4-7593 NEW YORK, N. Y. (Paramus, N. J.) New York City - BRyani 9-8042 Paramus, N. J. - Diamond 3-333 PHILADELPHIA, PA. PEnnypacker 5-3559 SAN FRANCISCO, CAL. EXbrook 7-6280 WINTER PARK, FLA. Midway 7-5501

"In Canada—Railway & Power Engineering Corporation Limited"

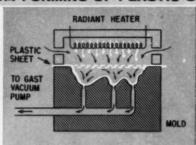
LORD MANUFACTURING COMPANY - ERIE, PA.

HOW TO APPLY GAST VACUUM PUMPS TO SOLVE PRODUCT DESIGN PROBLEMS

VACUUM FORMING OF PLASTIC SHEETS

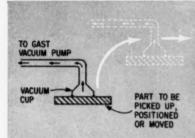
Many engineers are now pushing hard for improved designs on products used for: (1) Lower-cost parts forming, (2) materials feeding and (3) handling, (4) automatic control of machines, (5) faster testing and inspection. To suggest how Gast Vacuum Pumps (used as original components) might help you solve related problems, we offer these 5 examples:

1. VACUUM FORMING of thermoplastic sheet materials. Suction from Gast Model 1065 Vacuum Pump "drapes" heated plastic over male or female mold to make packages, products, parts, etc.





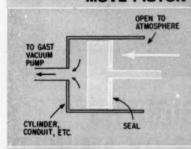
FEEDING OR HANDLING PARTS







MOVE PISTON OR DIAPHRAGM FOR AUTOMATIC CONTROL





- **VACUUM FEEDER** places U-board card into position on conveyor of cake wrapping machine. A ¼ h.p. Gast 0321 Integral-Motor Pump provides vacuum.
- 3. VACUUM HOIST handles flat stock in weights up to 1,000 lbs. per vacuum pad, using a ½ h.p. Gast Vacuum Pump. Safety device holds if power fails.
- 4 VACUUM WEB GUIDE for paper rolls prevents edge of paper from wandering, also keeps web tension constant. Two Gast Air Pumps activate controls.

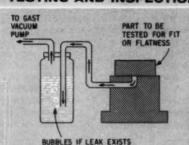
TESTING AND INSPECTION

WRITE FOR APPLICATION IDEAS BOOKLET-AND GAST CATALOG!

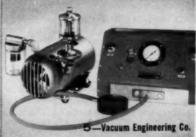
If the examples above interest you, request our "Application Ideas" Booklet. It contains 43 product stories like these, plus helpful diagrams on the uses of pneumatics.



"Air may be your Answer!"





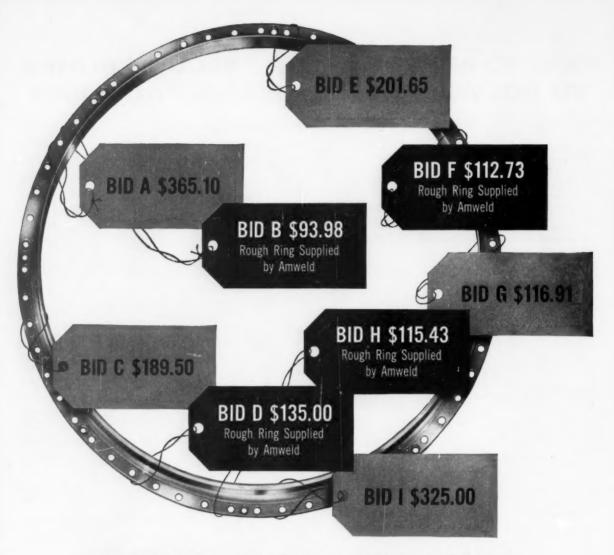


5. VACUUM TESTER checks surface flatness of parts against a standard. Vacuum level maintained by Gast 0321 Pump energizes 'go" or "no-go" lights.

O 1961, Gost Mfg. Corp.



ROTARY AIR MOTORS AIR COMPRESSORS VACUUM PUMPS



FOUR OUT OF FIVE LOW BIDDERS BASE QUOTES ON ROUGH RINGS BY AMWELD

Early this year nine companies submitted manufacturing bids ranging from \$93.98 to \$365.10 on this circular jet engine turbine shroud. Four out of the five lowest bidders submitted their finished shroud quotation based on rough rings, flash butt-welded, furnished by Amweld.

Whether you're bidding for military or commercial business, Amweld flash butt-welded rings can save you money—can help you get more business. The quality of Amweld rings

has been proved repeatedly in jet engines and missiles. The cost reduction opportunity presented by Amweld rings enabled Amweld customers to save over \$1,000,000 on circular components and assemblies last year alone.

Investigate now! Let Amweld review your circular component requirements and figure actual cost savings to you with Amweld flash butt-welded rings. Send your drawings and specifications today: The American Welding & Manufacturing Co., 903 Dietz Road, Warren, Ohio.



THE AMERICAN WELDING & MANUFACTURING CO., WARREN, OHIO



BED PLATE ASSEMBLIES GIVE PRECISION CONTROL
OF INFINITELY VARIABLE SPEED OUTPUT

Now, for the first time Cleveland's New Motorized Speed Variator may be engineered into compact, pre-tested drive arrangements for powering your driven equipment in non-hazardous locations. These assemblies are accurately pre-aligned at the factory—require little maintenance, only periodic oil changes.

HERE'S THE COMPLETE STORY:

- Requires only slightly more space than an equally rated standard electric motor
- Provides variable output speeds over 9:1 and 6:1 ranges
- •A complete line featuring 5 sizes from 1/3 to 15 HP
- Integral "pancake" style AC radial air gap motors conforming to NEMA design "B" specification
- Provides speed holding accuracy up to 0.1% with uniform loading
- Output speeds smoothly and easily adjusted while operating under load

These versatile mechanical-type drive units are especially applicable for chemical blending operations where it's important to hold fixed speeds. They can be run at definite speed settings for extended periods without localized wear of running parts or freeze-up of speed changing mechanism.

Variator is a true torque converter—provides high torque at low speeds for constant HP applications—gives traction even during periods of extreme overloading.

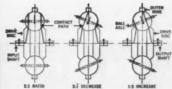
For complete engineering information on the *New* Cleveland Motorized Speed Variator, write for free, illustrated bulletin Number 275 or contact your Cleveland representative today.

Cleveland Worm & Gear Division

Eaton Manufacturing Company 3287 East 80th Street • Cleveland 4, Ohio







CONTROL VERSATILITY



for manual operation, a hand wheel is mounted on an extension of the control worm and equipped with a turns counter to indicate relative speed settings



For electrical remote - controlled operation, a small single-phase motor drives the worm through chain and sprockets, or enclosed gearing



This pneumatic operator accurately positions the control worm in direct relationship to a 3 to 15-pound air signal.

Flow The Speed Variator Works Power is transmitted through input shaft to a beveled drive disc in contact with axle-mounted alloy steel drive bails. Input shaft rotation causes bails to rotate about their axles. Power is then transmitted from all rotating bails to output shaft by similar ball-disc contact on the output side. Output speed is determined by relative lengths of contact paths on input and output sides of the bails. By tilting both axles and balls, relative lengths of the two contact paths are varied to give increasing or decreasing ratios as shown on the sketches.



NORGREN PRECISION PRESSURE REGULATOR

high sensitivity and exact accuracy of air pressure regulation

The new Norgren Precision Pressure Regulator, Type 20AS, is designed for air-gauging, laboratory use, pilot regulation and other applications where a high degree of accuracy and sensitivity is required for air pressure regulation. Operation of the new Type 20AS regulator is characterized by the following:

- 1 Accurate regulation at all flows up to the maximum flow recommended for ¼" pipe. This is more than 2 times the flow previously possible with instrumentation regulators.
- 2 Immediate response and high sensitivity.
- Exact repeatability and freedom from drift over short or long time operations.
- 4 Accurate regulation—even at delivery pressures below 1 psi.

SPECIFICATIONS:

0-60 psig secondary pressure 0-150 psig primary pressure 32° to 160° F temperature range 32° pipe size

See this regulator demonstrated at our booth in the

Design Engineering Show Detroit, May 22-25.

For complete technical information about the new Norgren Precision Pressure Regulator, call your nearby Norgren Representative listed in your telephone directory—or write factory for brochure NA-7.

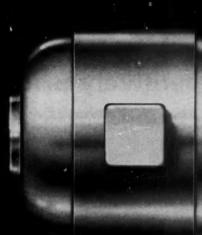
Founded in 1926

C. A. NORGREN CO.

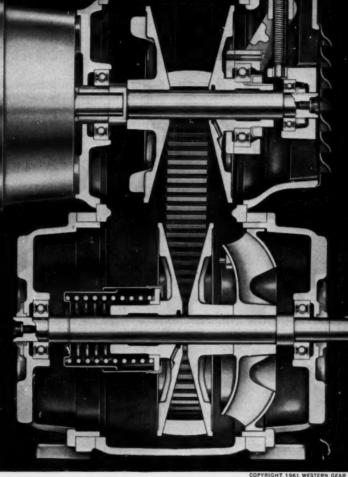
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YOU ASKED FOR IT!

VARI-MASTER by WESTERN GEAR



the variable speed-drive you designed



HOW WESTERN GEAR SERVES ALL INDUSTRY

Western Gear has designed, engineered and manufactured to customer requirements, the ultimate in

variable speed drives, combining all the best features of variable speed drives, plus Western Gear's own built-in reliability and versatility. Get unequalled performance in the new Vari-Master variable speed drive. You asked for, and Vari-Master delivers ■ unmatched flexibility ■ up-to-the-minute design improvements ■ utmost compactness ■ infinitely adjustable speeds = unlimited versatility = easy motor replacement = 120 basic configurations = superb quality. On the iong run... OUALITY COSTS YOU LESS! For full details, write Western Gear Corporation, Industrial Products Division, P.O. Box 126, Belmont, Calif., for Vari-Master Bulletin 6107F or ask your Western Gear salesman to deliver the 120-page Bulletin 6107.





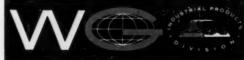








WESTERN GEAR CORPORATION

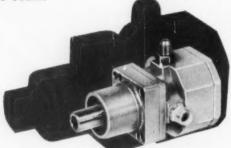


a new supplier of HYDRAULIC PUMPS

smaller · lighter · competitively priced

New Lucas-Rotax Industrial Hydraulic Pumps and Motors—now available in capacities from 1.5 g.p.m. to 108 g.p.m. and at pressures up to 5,000 p.s.i.— offer many technical advances to potential users. • Small in physical size, for considerable savings in size and weight over conventional models. • Relatively low noise level—no higher than competitive makes—in spite of higher operating speeds. • Fast response rate in pressure compensation. • Small and medium sized units can be operated from 2 pole motors to reduce the size and cost of prime mover. • Pumps are available as variable volume, variable volume pressure compensated, overcentre cam (reversible), or as fixed volume, as required. • Motors can be supplied in variable or fixed volume, as required.

• Both pumps and motors are designed to deliver high efficiency performance with low maintenance costs.



Size of Lucas-Rotax Type IA4 Pump is shown in relation to size of competitive unit of comparable rating.

a product of creative engineering by

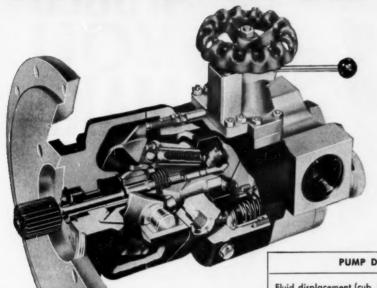
For further information contact U.S. Representative JULIUS KENDALL,

Kenett Corporation 320 Washington Street, Brookline 47, Mass. LOngwood 6-0378 LUCAS-

OFFICES AND SERVICE DEPOTS THROUGHOUT NORTH AMERICA

industrial

AND MOTORS



Lucas-Rotax Type IA 38-9 is a nine piston pump, variable volume, pressure compensated, designed for application on Ground Support Equipment.

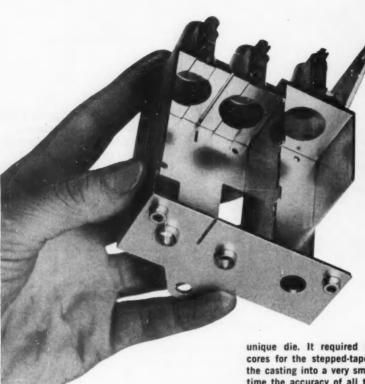
PUMP DETAIL	BASIC UNIT
Fluid displacement (cub. ins./rev.)	2.43
Working pressure—continuous	5000 @ 15 g.p.m.
(lbs./sq. ins.)	3000 @ 30 g.p.m.
Nominal speed (r.p.m.) peak	4000
—continuous	3750
Min. inlet pressure (p.s.i.g.)	10
Max. body pressure (p.s.i.g.)	200
Compensation speed (seconds)	.045
Operating Temperature (°F)	250 to -40
Weight (less A.N.D. flange)	37 lbs.
Direction of rotation	C/Clockwise
(viewed on shaft)	

Models are available from domestic stock in capacities from 1.5 g.p.m. to 108 g.p.m., capable of pressures up to 5,000 p.s.i. Write for technical literature, or contact the agent or office nearest you for further information.



BOSTON • NEW YORK • CHICAGO • LOS ANGELES • HOUSTON • SAN FRANCISCO • CLEVELAND JACKSONVILLE • DENVER • BALTIMORE • SEATTLE • TORONTO • MONTREAL • VANCOUVER 6003

HOW else



WOULD YOU MAKE IT?

■ Supplying this Motorola television tuner housing on a volume basis could have been a real production headache—were it not for the crackerjack combination of a die caster's skill and Zamak. With the performance virtues of these remarkable zinc die casting alloys in mind, Serv-All Tool and Die Company carefully worked up a

unique die. It required the withdrawal of three cores for the stepped-tapered holes at the rear of the casting into a very small area—yet at the same time the accuracy of all the diameters had to be held within plus or minus

.002". A piercing die was designed to punch the quarter-inch holes in the housing's three

MOTOROLA TELEVISION TUNER HOUSING

AWARD OF MERIT

The New Jersey Zinc Company's "Zinc Die Casting of The Year" Competition

"ears" as well as several undercuts impossible to cast. These holes were also held to plus or minus .002". ■ Serv-All knew Zamak could give them the castability they needed, could meet the demanding tolerances, could provide the high-strength, thin-wall sections required, and had the ductility for an accurate, easy piercing operation after casting. They also knew of the overall production economies inherent to Zamak—low die cost, long die life and high production speeds. One other characteristic of Zamak sealed the choice—the wide variety of finishing procedures which can be used. In this case the housing is copper-plated to facilitate soldering.

■ Zamak gives you more for less. How else would you make it?

THE NEW JERSEY

ZINC COMPANY

160 FRONT STREET - NEW YORK 38, N.Y.
DEVELOPERS OF THE ONLY STANDARD ZINC DIE CASTING ALLOYS IN USE TODAY



DESIGN

May 11, 1961



Four Kinds of Engineers

A T first the students were baffled. Their engineering textbooks included no formulas for solving the latest problem dreamed up by their prof.

Statement of the problem was simple enough: How long should a 3-pound beef roast stay in a 325 F oven for the center to reach a temperature of 150 F?

Under pressure, four patterns of attack emerged from four different men in the group of budding engineers.

There was the Big Project man. He didn't come up with a quick answer, but he had a well thought-out plan. His idea was to purchase an electric oven with precise temperature control, and some first-class indicating and recording instrumentation. A series of experiments designed to evaluate the significance of each parameter was outlined. Cost of the project was estimated and a proposal for obtaining a grant from one of the scientific foundations was drafted. With prompt appropriation and reasonable delivery he could have had an answer in six to nine months.

The Practical Approach appealed to another man. He went out and bought a roast at the local market, an oven thermometer and a meat thermometer at the five and dime. He cooked that roast in a kitchen oven (service environment) and timed it with his wrist watch. While munching medium-rare roast-beef sandwiches, he wrote his report.

The Supported Judgment man got a quicker answer. He reasoned that animal tissue is mostly water and therefore should have about the same specific heat and conductivity. Handbook values gave him the data he needed to apply his basic heat-transfer theory. His answer was within minutes of that reported by the Practical Approach man.

The quickest answer came from the student who simply consulted his mother by phone,

Which of these men would you say promises to be the most effective engineer?

bolin Carmilal

EDITOR

Should a company do its own research and development work—or hire an outside agency for the job? Here is a close look at the advantages and problems of

Hopfoll Higher Life

Using Outside R&D

ROBERT G. MURDICK

Dept. of Management Engineering Rensselaer Polytechnic Institute Troy, N. Y. Uniterilies & Colleges Light Light Consoled light

Pros and Cons of Outside R & D

- Buying outside technical services reduces the need for capital investment in facilities and/or an increased research staff which may not be needed in the long run.
- The cost of outside research is often less than conducting the work within the company.
 Large companies, for example, often have much higher overhead rates than outside research groups. Furthermore, cost control is apt to be tighter and evaluation of research progress more critical if an outside agency is used.
- The sponsor gets the benefit of a wide variety of skills since the people working on his project have ready access to their associates within the outside laboratory or firm.
- Research groups, because of their broad background, may suggest new marketing applications of products.

- Psychologically, a problem sometimes arises with the engineers and scientists employed by the sponsoring company. Some employees consider outside research a reflection on their own ability and a use of funds which should be expended for building up their own organization.
- Since the outside research group is frequently not familiar with the operations of the firm, sometimes a long period of time is wasted just "learning the ropes" and training the
- When an outside agency is used, the engineers and scientists of the company lose the
 experience and technical skills always gained
 during the life of a research project. This
 factor may be the greatest disadvantage of
 using outside research, because no price can
 be put upon experience.
- Some outside research groups are overly optimistic about their ability. They must take an optimistic view to sell their services and sometimes cannot produce as much as they have proposed.

SE of outside agencies for R & D work is a large operation today, and is rapidly growing. According to one estimate, over 8000 companies sponsor outside R & D each year. A survey by the National Science Foundation a few years ago showed that about 74 per cent of the companies with more than 5000 employees sponsored outside R & D. However, outside research may be a wise investment for any company, large or small.

Outside research includes scientific, technological, and engineering development, or economic evaluation of technical alternatives, carried out for a company or government agency by another company, institution, group, or individual. Such work is almost always directed towards a specific objective; that is, it is in the nature of applied research or specific engineering development.

Scope of the R & D work may range from a million-dollar project to a consultant's services for a few days. The contract may call for complete handling of a large R & D project, investigation of a highly technical and specialized problem, management guidance of the contractor's R & D, testing of a product or process, or, simply, technical counsel in some area.

The principal reasons for contracting R & D work are summarized on the next page.

Sources of Outside R & D

Many sources of research and development are available to companies today, and the number is increasing yearly. Each source has different qualifications which may suit the needs of a specific research problem.

Universities and Colleges: Many universities accept research grants from industry. However, the sponsoring company normally has only limited control over the project.

University research is of particular value in training useful scientific personnel for industry, and in putting the company in close touch with outstanding graduate students who will enter industry.

Nonprofit Research Groups: These research foundations and institutes operate on a large scale in the United States. They may be privately endowed or university sponsored, but they are all independent nonprofit organizations. These groups are equipped to handle intradisciplinary research problems which a single company could not afford to do. They are much larger than independent laboratories and can conduct big projects. Some of the largest are:

- 1. Battelle Memorial Institute
- 2. Stanford Research Institute
- 3. Cornell Aeronautical Laboratory
- 4. Armour Research Foundation
- 5. Mellon Institute Research Foundation
- 5. Mellon Institute Research Foundation
- 6. Southwest Research Institute
- 7. Franklin Research Institute
- 8. Midwest Research Institute
- 9. Southern Research Institute

Individual or Group Consultants: Often specialists can be brought in to give advice on and/or to direct a specific research project. These experts may be members of a consulting firm which specializes in certain kinds of work. They also may be individual consultants from university faculties, or engineers and scientists who have left industry after establishing outstanding reputations in their fields.

Independent Research Laboratories: Approximately 2500 independent research laboratories in the United States are in business primarily to provide consulting and laboratory services for companies, individuals, or institutions. Unlike the research foundations, these laboratories are profit-making organizations.

Government Laboratories: Vital research is being conducted constantly by various government agencies such as National Bureau of Standards, Agricultural Research Administration, Atomic Energy Commission, and Bureau of Mines. The results of all nonclassified (security) research are available to industry.

"Captive" Laboratories: Often, a manufacturer who

The company may not be able to justify a permanent research facility and staff of its own. Or, the company may find that some specialized work can be done at less cost by an outside group.

Overflow Work

The normal size of the company research staff should be fully utilized when work is low. Thus, at peak loads the staff will fall behind. Scheduled commitments may require that peak work not be delayed; therefore, it is necessary to farm out some research projects.

· People

There may be jobs requiring a technical specialty, which no one on the staff possesses. It may be that the company would like to hire a certain type of specialist, but has been unable to do so for a number of reasons.

· Facilities

There are few, if any, companies whose research facilities entirely fulfill their needs. When very expensive equipment is needed for a single project, the only practical course is to obtain the services of an outside facility.

Information

A contract R & D agency, which has performed certain work for another firm in the past, may have developed valuable information which has been kept restricted. While ethical research groups will not work on a similar project for a second firm until after a period of time, they may be willing to do so at the end of that period.

Subjective Factors

The internal research organization is often without prestige in its own company. When the research director desires to sell management on a certain program, he may recommend accepting a solicited proposal from an outside research group.

Corroboration

V aen the company's research staff has turned up a highly significant result which affects both the product and its advertising, an independent check by an outside group may be desirable. Special advantage may be achieved if it is possible to arrange for use of the outside agency's name in advertising.

· Co-operative Projects

Often industry-wide problems appear for which there is no gain for the individual firm to find the solution alone. All firms may then band together to sponsor jointly the research required. Such joint action may also be necessary because of the tremendous cost of the project.

• Parallel Programs

When time is important, or the best possible solution among alternatives is required, outside research is usually the answer.

• Industry Data

Industry-wide programs for generating test data or developing standards or technical data may be sponsored on a continuous basis by firms in an industry to insure a high-level unbiased technical development or data-gathering effort.

supplies materials or equipment to a company will conduct helpful research which may eliminate the need for the company to spend its own time and money on a project. Thus, the manufacturer improves his own product and the buyer benefits also. Sometimes two or three companies will set up an independent laboratory and will share the results of the research.

Industry-Sponsored Organizations: Three groups of laboratories fall in the industry-sponsored category: 1. Those sponsored by an industry (Trade Associations). 2. Those sponsored by professional associations. 3. Those sponsored by co-operatives. These organizations conduct research only on an industrywide scale, and their services are available to all members

How to Select an R & D Group

A checklist of points to consider in selecting the outside R & D group is given on the facing page. When a number of good possibilities have been isolated, these questions may help to narrow the choice:

1. What experience has the particular agency had

in the field of this problem?

2. How successful has their research group been in dealing with other clients? Try to talk to some of them.

3. Does the outside group have a good scientific library, or access to one, and does it have a highly

developed and efficient search system?

4. How much research work is initiated by the agency itself? This is a measure of its initiative and creativity.

5. What form of contract does the research group use? Is there considerable flexibility in their contractual relationship or do they work under standard contracts?

Contracts

The sponsoring companies usually enter into a contractual arrangement based upon simple standard contract forms originating with one of the parties. If the project is of considerable size or is undertaken for the government, a carefully drawn legal document may be necessary. A surprisingly large number of contracts are simply letters of agreement, where the sponsor depends upon the known ethical standing and procedures of the research group.

Before the details of the project are spelled out in an agreement, responsible representatives of both the sponsor and the outside R & D group should jointly define the problem and classify the desired objectives. Preliminary conferences also show up personality or philosophy clashes which may prevent a true partnership from developing. Also, the outside group, because of its fresh perspective, may un-

Choosing an Outside Agency

cover the fact that the real problem is not what the sponsor thought it was. It is well to uncover and discuss such a major point before a definite agreement

To protect both parties, the standard agreement usually provides for cancellation of the contract by either party upon reasonable notice. Results cannot be guaranteed in research so that most contracts are on a "best efforts" or time-and-materials basis. When the work is at the engineering end of the spectrum, fixed-fee contracts are possible, Consulting firms or individual consultants may also charge a fixed fee for a specific analysis or study.

Scope: The scope of the project may be spelled out in a proposal prepared by the outside group after conferences and discussions between the parties. The statement of scope covers the objectives, the approaches to be investigated, the extent of the personnel and facilities to be applied, and the limitations of the areas to be investigated.

Schedule: The contract may establish a specific end-date based upon funds available, or the project may be planned to continue until the problem is solved or one of the parties cancels the contract. The more clearly the work is defined, the more detailed the schedule should be.

Cost: The rate at which charges are to be accumulated, or the maximum amount that can be spent by the outside facility without written permission from the sponsor, is usually specified in the contract. The frequency of billing and of progress or advance payments are other points to be covered.

Reporting: The frequency and type of formal written report depend upon the size of the project and its duration. For a short project of a few months, a final report may suffice. For projects lasting about a year and representing medium costs, reports at logical partial-completion points are desirable. For large projects representing large costs and extending over several years, both monthly progress reports and technical topical reports on completed phases of the work usually will be required.

Working Relationship: Most generally, patent rights are assigned to the sponsor. Also, arrangements are usually made to maintain in confidence work conducted for the client. Conflict of interest is avoided by most outside research groups by not undertaking similar work for a competing sponsor until after a specified time.

However, not all research groups work under these same general rules. Many groups share or maintain an interest in patent rights. The contractor should explore these questions in the preliminary meetings.

On the other side of the coin, outside research

- What work has been done in the field? If a company is too far behind it might be well not to try to catch up.
- Have competitors solicited the same research, and from whom? Private research institutions will not accept work from two competing firms within certain time limitations.
- 3. Does the problem involve basic research, or development of existing technology? For basic research, universities and research institutes are the best source. For the answer to a specific problem, independent laboratories are the best bet.
- Is the information needed of a proprietary nature?
 Must a patent be obtained? If so, profit-making institutes and consultants are the likely choices.
- Is this problem concerned with only a particular industry? If so, an industry-sponsored laboratory, because of its experience, might be better suited to do the job.
- Must the work come up to industry standards?
 An industry-sponsored laboratory is probably best equipped. University research is usually too theoretical.
- 7. Is the project large or small? If the project is large, \$10,000 to \$1,000,000, the research foundations are equipped to carry on the job. (They will take small jobs too, of course.) Universities can handle grants from \$1,000 to \$100,000. Independent laboratories and consultants will handle work according to their size and number of employees. Some laboratories put limits on the amount of a contract they will accept.
- 8. Is a long or short-run project anticipated? Research institutes and universities are used most frequently for projects which run from three to five years. Consulting firms and independent laboratories are best for quick results.
- Will any follow-up be necessary? If so, will it be undertaken by the company or the outside agency?
- 10. Does the company want research effort alone, project management alone, or both? If the project requirements, in terms of job duties and personnel qualifications, are known, it is cheaper to hire specialists rather than complete research teams. When a large project of greater-than-usual scope is involved, it may be necessary to hire outside research management.
- 11. Will special equipment be required? Does such equipment exist and if so, who has it, and will it be needed when the program ends?
- 12. Will the company pay for the entire project, or is it just planting the seed? Rather than supporting the whole project, a company may just want to get it started in the hope that the government or other companies will become interested and will either pick up the bill or share the expenses after the company's money runs out.
- 13. Will there be further occasion to use the outside research facility? Once having worked for a company the group will be trained to its needs. This training can be a valuable asset in the future.

groups perform their work on a professional basis and usually do not allow their names to be used in advertising.

Ligison

After the contract is signed, the matter of liaison between the company and the outside R & D agency requires special attention. Although the basic responsibility for carrying out the program rests with the outside group, the sponsor company must act as a partner in the venture. The sponsor must share its background and experience and yet allow freedom of investigation.

A technical program of more than minimum scope cannot usually be laid out in detail in advance. Technical or administrative decisions on the program will need to be made along the way. For this reason, responsible technical representatives should be established by both parties for the "official" transmission of decisions and information.

This arrangement does not mean that all contact must be made through the liaison officers. On the contrary, freedom of contact and sharing of ideas should be encouraged at all levels of organization. Regularly scheduled meetings and written reports also help to maintain a close partnership.

To a great extent, the success or failure of the program depends upon the compatibility of the two parties and the degree of freedom given to the outside R & D organization. Interchange of information and discussion of objectives are healthy, but overzealous interference on the part of the sponsor can be fatal. The sponsor must be patient and must understand the limitations of the research process—

for every miraculous discovery there are dozens of failures and disappointments. If the sponsor follows and understands the details of the research, he can profit even from the failures.

▶ The Small-Company Outlook

For small companies, outside R & D facilities can fill a special need. Many small companies get started on one product developed by the founder. Some of the luckier ones have added related products in response to their customers' requests. There comes a time, however, when these firms must diversify further or make significant improvements in their products to maintain the lead over other small firms which are continually trying to gain a foothold in the industry.

The very small companies cannot afford to maintain a research staff and adequate facilities. The "larger" small companies, in general, can conduct some of their own research, but they also may want to utilize outside research for many of the reasons

given previously.

Most small businesses fail to utilize outside R & D for two reasons:

- They do not understand the need for continued product development and the role of R & D.
- They are unaware of the uses, sources, and costs of outside R & D.

Fear of high costs for outside technical assistance is largely unjustified. One of the independent research institutes reports that about one-sixth of their projects amount to less than \$1000 in total cost. About a third are between \$1000 and \$15000, and another third are in a range of \$5000 to \$7500.

Tips and Techniques

Hydraulic-Leak Detection

Microscopic leaks in hydraulic systems, generally hard to detect, can usually be located by an inexpensive visual technique.

A small quantity of fluorescent dye (oil, water, or spirit-soluble, whichever is appropriate) is dissolved in the hydraulic fluid. The exterior surfaces of the system are then examined under ultraviolet light. Even though a leak may be so small that the fluid evaporates on escaping, the point of failure will fluoresce because of the dye deposited there.

Before this procedure is used, the exterior of the system should be examined under the light and carefully cleaned of any substances that may show the same color as the dye tracer. Pressurization will speed the flow of fluid through a defect, but usually at least a day should elapse before a thick metal sec-

tion can be certified as sound.

Most chemical supply catalogs list a variety of dyes and lamps or fluorescent tubes that will produce ultraviolet light.—Donald F. Janous, Chicago, 111.

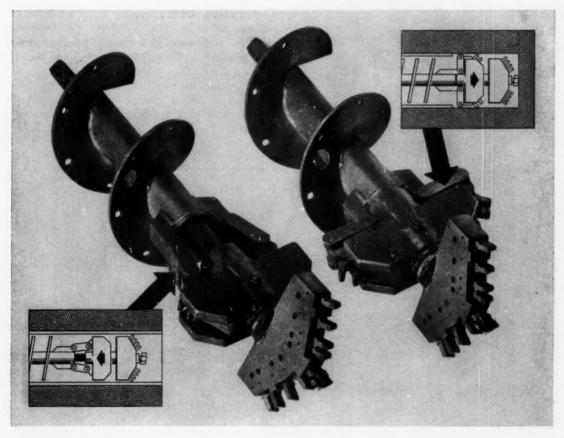
Multiplying by e

The value of e, which is an improper number, may become unwieldy in certain calculations. When this occurs, the fractional value, $e\!=\!310/114$, may be sufficiently accurate and is much easier to use. This value has an inaccuracy of only 0.001.—Morris A. Suntop, Rochester, N. Y.

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniquee Editor, MacHINE DESION, Penton Bidg., Cleveland 13, O.

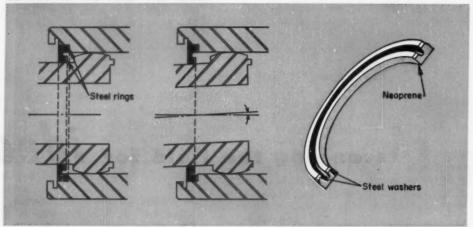
scanning the field for ideas

Folding toggle linkage forces cutting teeth to project beyond nominal diameter of a cutting head. Thus, a tubular casing, which is slightly larger than the nominal cutting-head diameter, can be advanced directly behind the cutter to support the hole. When the drill is retracted, the linkage withdraws the teeth to permit the cutting head to pass through the casing. Principle employed in a trench drill by Salem Tool Co., Salem, Ohio.

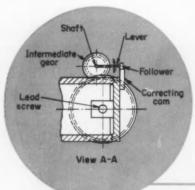


May 11, 1961

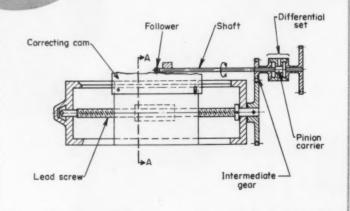
SCANNING THE FIELD FOR IDEAS

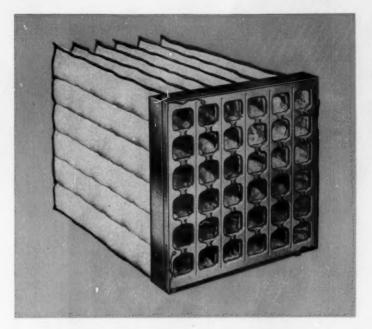


Hinged concentric rings float radially to maintain sealing during angular misalignment of a flexible coupling. The steel rings are bonded to a neoprene seal which has a reduced "hinge" section. Principle employed in a seal by Sier-Bath Gear and Pump Co. Inc., North Bergen, N. J.



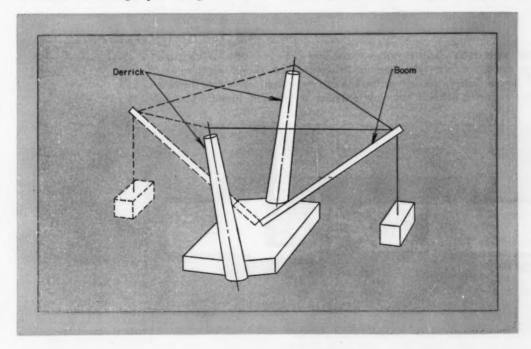
Correcting cam provides input to differential gear set in the drive train of a lead screw to offset the pitch errors of the screw. Motion corrections produced by the cam profile rotate the pinion carrier (spider). The linear cam is attached directly to the table driven by the lead screw. Principle employed in thread grinder by VEB Freiberger Praezisionsmechanik, Freiberg/Sachsen, Eastern Germany.

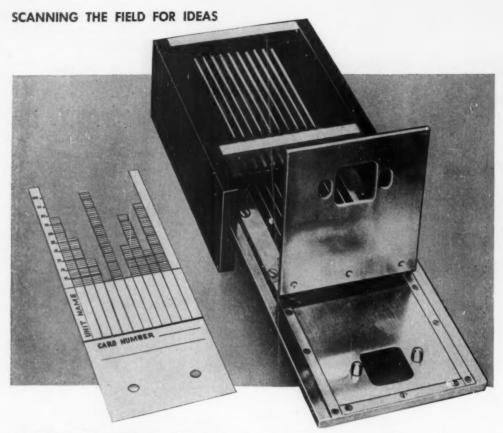




Air-inflated sleeves increase effective filter area with no increase in over-all cross section of the assembly. When the air system is shut down, the sleeves collapse to permit easy installation or removal of the assembly. Principle employed in a filter by American Air Filter Co. Inc., Louisville, Ky.

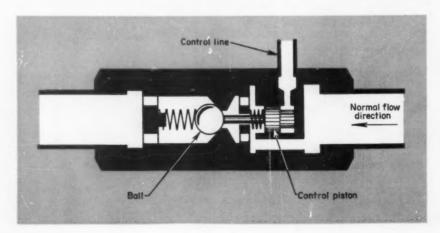
Twin-span support permits boom to pass "over center" and operate on either side of derrick. Usual single-span arrangement restricts boom operation to one side only. Boomprinciple, employed on cargo ship, developed by H. C. Stulken Sohn, Hamburg, Germany.

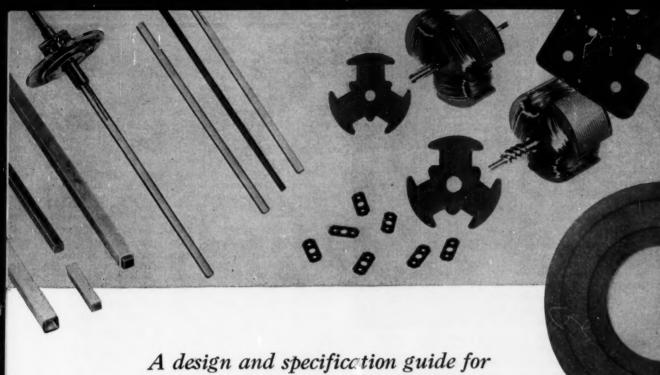




Variable-length "fingers" on a plastic card provide information storage and read out. The cards can be prepared by hand cutting with scissors or by use of a card punch. Principle employed in a card reader by Jordan Controls Inc., Milwaukee, Wis.

Piston releases ball to permit reverse flow in a check valve. With no pressure on the piston, the valve operates as a regular check valve. However, if reverse flow is desired, the ball can be unseated by pressure applied to the piston. Principle employed in check valve by Heilmeier & Weinlein, Munich, Germany.





Laminated-Plastic and **Vulcanized-Fiber Parts**

F. J. HUTTA

Manager, Planning and Engineering Taylor Fibre Co. Norristown, Pa.



Fig. 1—Small-lot production of dis-tributor caps for test engines utilizes the good machinability characteristics of vulcanized fiber. The caps were machined from sheet stock. In lots large enough to spread tooling costs, caps would be molded.

ESIGN of a laminated-plastic or vulcanized fiber part must take certain basic properties into account-if a quality part is to be produced easily and at lowest cost. Also, method of fabrication, tooling, and possible cost-saving in production operations must all be considered at the design stage—and the drawings and specifications should spell out the necessary details.

Based on a study of common errors in designing and specifying parts, this article describes principles of sound specification practice and particular design details that apply to these materials.

Characteristics and Fabrication

The characteristics of both laminated plastics and vulcanized fiber which most affect design and specification of parts made from them are those

VULCANIZED-FIBER PARTS

resulting from the resilience and from the laminar structure of the materials.

Any fabrication operation parallel to the laminations is in the weakest direction of the material and should be avoided. Where the design will permit, operations such as drilling, tapping, and broaching should be done perpendicular to the laminations.

Both materials can be machined on standard wood or metal-working equipment, Fig. 1. In addition, they are easily formed, either by molding plies of the coated base material under heat and pressure or by postforming (heating and forming) laminated sheets.

The strength-to-weight ratio of several laminatedplastic materials averages 58 per cent higher than that of alloy steels. Other properties of these materials include high heat-insulation and electricalinsulation characteristics, good machinability, good wear resistance, and high resistance to steam, oil, and corrosive atmospheres.

Laminated plastics and vulcanized fiber are generally easier to machine than metals; they require few special machine tools.

Among the properties of these materials which require modification of metal-machining practices

- 1. Low shear strength permits high cutting speeds and feeds, even on machines of light construction.
- 2. Resilience of the materials requires sharp cutting tools with greater clearance and less rake than those used for metal parts. Resilience necessitates more lib-

- eral tolerances than those that can be held on metal parts. Also because of resilience of the materials, drilled and punched holes must be made with tools slightly larger than the desired hole diameters.
- 3. Low thermal conductivity requires greater cooling provisions for the work and cutting tools than those needed for metal machining.
- 4. Laminations in the material require confining jigs to prevent splitting of the laminate when it is necessary to machine parallel to laminations. Precautions are also required to minimize chipping on the lower or break-through surface when brittle materials are drilled

Ordering Information

Sometimes the user of materials purchases standard sheet or rod stock and fabricates his own parts. More frequently, users purchase parts either partially or fully fabricated from the material supplier. In either case, the supplier should be given complete information about the part to be fabricated.

Complete information includes the material specification, mechanical, physical, and electrical requirements, a drawing with full dimensions and tolerances, and end-use information on the function and environment of the part. If the user is to make the part, information about the method of fabrication also should be included.

When the supplier is to fabricate the part, it is better not to specify the method of fabrication. Some grades of materials are better suited than others to different fabricating methods. The supplier is in a good position to decide which method

Table 1—NEMA Standard Thickness Tolerances on Laminated-Plastic Sheets

				- NEMA Grade	*			
Thickness, Nominal (in.)	X, XP, XX, XXP, XXX, XXXP, FR-3	c	CE, A	L	LE	AA	G-3, G-5, G-7, G-10, G-11	NS
Telerances, 1 0.815 0.815 0.620 0.025	Plus or Minus† (in 0.002 0.0025 0.003 0.0035	 	0,005	0.003 0.0035 0.004 0.0045	0.0035 0.004 0.0045	***	0.002 0.030 0.004 0.005	0,003g 0,005 0,005
5 to	0.0035 0.0045 0.005 0.007	0.0065 0.0075 0.0075 0.009	0.0065 0.0075 0.0075 0.009	0.005 0.0055 0.006 0.007	0.005 0.0055 0.006 0.007	0.018 0.018	0.0065 0.0075 0.0075 0.009	0.0068 0.0078 0.0078 0.009
% **	0.068 0.009 0.010 0.011	0.010 0.011 0.0125 0.014	0.010 0.011 0.0125 0.014	0.008 0.009 0.010 0.011	0.008 0.009 0.010 0.011	0.020	0.012 0.015 0.019 0.021	0.010 0.011 0.012 0.014
1/4 1/8 1/6 1/6	0.012 0.0145 0.017 0.019	+ 0.030 + 0.035 + 0.040 + 0.044	0.015 0.0175 0.020 0.022	+ 0.024 + 0.029 + 0.034 + 0.038	0.012 0.0145 0.017 0.019	0.028 0.034 0.038 0.044	0.022 0.026 0.030 0.033	0.015 0.024 0.032 0.040
1/4 9/4 9/4 9/4	0.021 0.024 0.027 0.030	+ 0.048 + 0.053 + 0.058 + 0.062	0.024 0.027 0.029 0.031	+ 0.042 + 0.048 + 0.054 + 0.060	0.021 0.024 0.027 0.030	0.048 0.058 0.068 0.076	0.036 0.040 0.043 0.046	0.048 0.054 0.058 0.062
1 11/4 11/4 11/4	0.033 0.035 0.037 0.039	+ 0.065 + 0.069 + 0.073 + 0.077	0.033 0.035 0.037 0.039	+ 0.065 + 0.069 + 0.073 + 0.077	0.033 0.035 0.037 0.039	0.086	0.049 0.053 0.055 0.058	0.066
1 1/6 1 1/6 1 1/6 1 1/6	0.041 0.043 0.045 0.047 0.049	+ 0.081 + 0.085 + 0.089 + 0.093 + 0.097	0.041 0.043 0.045 0.047 0.049	+ 0.081 + 0.085 + 0.089 + 0.093 + 0.097	0.041 0.043 0.045 0.047 0.049	0.124 0.144 0.160	0.081 0.064 0.067 0.070 0.073	:::

n, paper-base Grades: X, XP, XX, resin, paper base: FR-3. Phenolic see: C, CE. Phenolic resin, fine-weave LE. Phenolic resin, asbestos paper b

glass fabric: G-3. Melamine resin, glass fabric: G-5, Silicone resin, glass fabric: G-7. Epoxy resin, glass fabric: G-10, G-11. Phenolic resin, nylon fabric base: NS. fAll tolerances are plus or minus except those preceded by a plus sign. These are plus only.

will best meet the specifications and requirements of the part at the least cost.

Drawings: Block dimensions and tolerances or drawings are often a source of confusion. Block dimensions standardized for metal parts are usually unrealistic when applied to laminate or vulcanizedfiber parts. Tolerances should be repeated beside each dimension to which they apply.

Another common problem is caused by the failure to bring revisions up to date on old drawings of parts already completed. Differences in dimensions or tolerances should not only be shown clearly on the blueprint but should also be pointed out in the accompanying order. When a new drawing obsoletes previous ones, this should be clearly noted.

When slight, permanent revisions to part drawings are to be made, it is advisable to determine whether or not the existing tooling can be modified to take care of the change. Modification can often be done at less cost than making a new die.

Specifications which accompany the blueprint should fully interpret all notes on the print. Copies of engineering standards, manufacturing standards, or other standard instructions which apply should also accompany the order.

Common Specification Omissions: Incomplete part specification can lead to delays or to parts being made to "unless-otherwise-specified" standards (which may be unsatisfactory). Some of the most common omissions are:

1. Thickness tolerance. Both laminated-plastic and vulcanized-fiber materials are made to standard toler-

Laminated plastics, also known as reinforced plastics, are made by impregnating paper, cotton, asbestos, glass cloth, nylon, or other base materials with phenolic, melamine, silicone, or epoxy resins and building layers of these materials to desired thicknesses. The laminate is then subjected to heat and pressure which fuse it into a dense, insoluble, homogeneous material. Composite laminates are made by facing or sandwiching basic laminated plastic materials with vulcanized fiber, rubber, copper, lead, aluminum, magnesium, stainless steel, beryllium copper, or other materials.

Vulcanized fiber, a regenerated cotton cellulose material, is made by passing layers of paper through a bath of zinc chloride. The solution gelatinizes the paper, and causes the individual fibers in the various layers to cohere into a homogeneous sheet. The resulting product, after being leached, dried, and finished by calendering, is a dense material in which the fibrous structure remains intact to varying degrees, depending on the grade being processed.



Fig. 2—Diameter tolerance of +0.000 in., -0.002 in. is held on ends of laminated-plastic coil form. Stop collars are also made of laminate material. Fabrication of all three parts ordered together permits dis-tribution of tolerances between ID of collars and OD of coil form for the specified slip fit.

Table 2—NEMA Standard Tolerances

Tolerance, Plus or Minus (in.)
Tubing (ID Tolerance)
0.003
0.004
0.008
0.010
and Molded Red (OD Tolerance)
0.005
0.008
0.025

Operation		Plus or Minus (in.)		
Sand one side	12 0.002	Sheet Width (in.)- 24 0.003	48	
Sand two sides	0,001	0.001	0.002	

ances, Table 1 and 2, but closer tolerances can be held by sanding, Table 3. If closer-than-standard tolerances are needed, the specification should call for sanding and should indicate whether the material is to be sanded on one or both sides. Sanding adds about 10 per cent to material cost.

- 2. Color. Vulcanized fiber and most laminates can be supplied in a number of colors. The natural color is supplied unless otherwise specified.
- 3. Finish. If finish is not specified, complete end-use information should be included so that the supplier can furnish the part in the best finish for the appli-

VULCANIZED-FIBER PARTS

cation. If fungus-proofing is required, the applicable military specification should be noted.

- 4. Creasing or scoring. Vulcanized-fiber parts can be creased or scored for subsequent bending. Scoring cuts the surface of the fiber and should be specified when the bend is to be made away from the line. Usually, scoring is not needed on material less than 0.030 in thick. Creasing merely compresses the material along the crease line and should be specified when the bend is to be made into the line.
- Holes. If a screw or bolt requires a force fit into a hole, the exact hole size should be specified. Tolerances on different types of screws and bolts vary, and the desired fit cannot be assured unless the required hole size is specified.

Cost-Reducing Considerations

Because the cost of a part can vary widely with quantity, it is desirable to consider quantities on an annual-requirement basis. Tooling can then be designed for optimum economy of production.

Similar Parts: Parts made from the same grade and thickness of material can often be produced

No-Cost Extras

- Color-facing of paper-base laminates. Production quantities of laminate materials can be faced on one or both sides with almost any color at no extra cost. Color-faced laminates are often used to identify the source of supply, to facilitate assembly of unsymmetrical parts which look symmetrical, to identify parts with small differences in thickness, to identify similar parts that are of slightly different sizes, or to identify parts according to end use.
- Paraffin coating of small parts (to reduce water absorption).
- Distributing the allowable tolerance on the plus or minus side.
- Scoring, creasing, or embossing (except for tooling costs) that can be performed simultaneously with other operations.

more economically by combination tooling. Also, parts having only minor differences may permit the use of interchangeable tools, thus reducing total tooling costs. For example, two different parts requiring different sized holes, but in the same positions, can often be made more economically by a tool that incorporates removable punches than by two separate tools.

Parts for Assemblies: When a number of lami-

nated-plastic or vulcanized-fiber parts are to be fitted together in an assembly, the specifications should call for no tighter fit than is necessary. Although fairly close dimensions can be maintained, tolerances cannot be held as close as with metal parts. Thus, the cumulative error of the mating parts can become more pronounced.

The best approach, where mating parts are of the same type of material, is to order them together or as assemblies, Fig. 2, and to indicate whether a slip fit, press fit, or force fit is required. Tolerances can then be distributed on the plus or minus side for both parts to produce the required fit. For the same reason, when laminate or vulcanized parts are to fit parts of other materials, samples and prints of the latter should be supplied with the order.

Edges: Punching laminated-plastic and vulcanized-fiber sheets that are over ½-in. thick usually produces rough edges. Edges can be smoothed by shaving, at a cost of two to three times that of the normal punching operation. Also, shearing of sheets over 1/16-in. thick, produces rougher edges than sawing. Sawed edges can be held to closer tolerances but sawing costs about twice as much as shearing. Sheared edges can be held to a tolerance of ±0.010 in. In general, smooth edges should not be specified on thick pieces unless necessary for function or appearance of the part.

Hole Breakout: Holes in laminate and vulcanizedfiber parts should be no closer together or no closer to an edge than the thickness of the material. Otherwise the web material may break out. When breakout of holes along the edge of a piece is not important, this should be stated in the specification.

Haloing: Also known as corona effect, haloing usually takes the form of bumps or crazing around the edges of a hole. This effect is caused by the drill or punch pushing through the material, Fig. 3. Haloing is most likely to occur in the more brittle grades of laminates such as glass-base, Grade XXXP

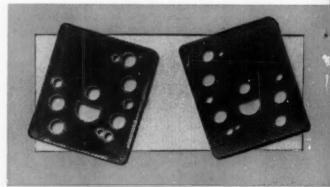


Fig. 3—Stamped glass-melamine part, left, shows "haloing," a common occurrence in the more brittle laminate materials. Clamping or backup devices used in fabrication can minimize or eliminate this effect, right.

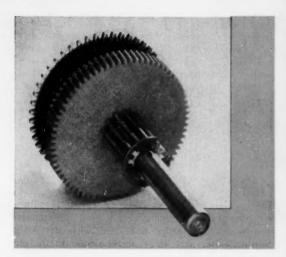


Fig. 4—A change in material specifications to a more expensive laminate (canvas phenolic to linen phenolic) reduced cost of small gear blanks by 18 per cent. Reason: The blanks could then be punched instead of fly-cut. Linenbase laminate also increased life of gear.

paper-base, and the metal-clad laminates. Haloing can be minimized with the use of clamping devices during the fabrication process. The function and strength of the part are not affected by haloing.

Material: Phenolic paper-base laminates are the least expensive of the laminated-plastic grades and should be considered where design permits. Still lower in cost are the vulcanized-fiber materials, which have excellent electrical-insulation properties and good mechanical strength.

Sometimes, however, the use of a more expensive material can reduce the over-all cost of a part, Fig. 4. Canvas-base laminates cost more than paper-base grades, and linen-base grades, more than the canvas, but fabricating properties improve in the same order.

Conflicting Specifications: A clash between properties of the material selected and specifications of the finished part can cause conflicts. Some are:

 Bright finish on laminate parts. A bright finish requires a higher-than-normal resin content in the lami-

Table 4—Normal Fabrication Tolerance— Punching, Turning, or Drilling

NEMA Grade	Thickness (in.)		Toleran	co, Total	
-		——-Но	llank Size (ir	(in.)—	
		To 1/4	1/4-1/2	1/2-1	1-3
XP	a.	0.004	0.004	0.005	0.008
	7.	0.006	0.006	0.006	0.010
	1/2	0.008	0.008	0.008	0.012
XXP	2	0.005	0.007	0.007	0.010
	32	0.007	0.008	0.008	0.012
	ż	0.008	0.010	0.010	0.015
XXXP	٦.	0.005	0.007	0.008	0.010
	32	0.006	0.008	0.008	0.012
	**	0.008	0.010	0.010	0.015
L		0.004	0.005	0.006	0.010
	32	0.005	0.006	0.007	0.010
	Tr.	0.008	0.010	0.012	0.012
C	1	0.005	0.006	0.008	0.010
	1/2	0.006	0.008	0.010	0.010
	12	0.008	0.010	0.012	0.012

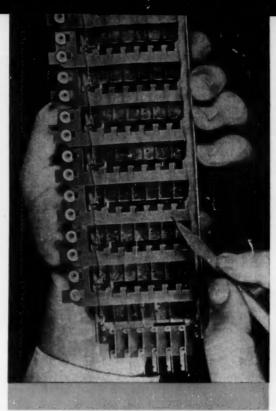


Fig. 5—Tolerance build-up on length (2.955 in.) of precision laminated-plastic pusher-arm parts is held to plus or minus 0.002 in.; flatness, to plus or minus 0.005 in.

- nate. Because high-resin laminates are relatively brittle, parts are more susceptible to haloing and chipping during fabrication.
- Smooth, machined surface. Linen-base laminates produce the best machined surface but they are weaker
 than canvas-base laminates and have less electrical
 resistance than paper-base grades. A smooth finish
 should not be specified if other properties are more
 important.
- Close tolerances on glass-base laminates. Cutting tools dull rapidly on glass-base laminates. Generally a choice must be made between using glass-base laminates and holding close tolerances.

Design Tolerances

One of the most common errors in specifying laminate and vulcanized-fiber parts is designing to unrealistically close tolerances. Normal fabrication tolerances are wider than can be held on metal, Table 4 and 5, mainly because both laminated plastic and vulcanized fiber are more resilient than metal. In general, metal parts can be held to tolerances in the ten-thousandths of an inch while tolerances on laminates and vulcanized fiber are usually measured in thousandths.

This does not mean that closer fabrication tolerances than those shown cannot be held. In some cases, the requirements of the application may make the additional cost practical.

When extra close tolerances are specified for

VULCANIZED-FIBER PARTS

holes without any real need, fabrication usually requires drilling when the less expensive punching would do. Jack spacers, for example, have been specified with ±0.001 in. tolerance on the hole diameters, but since wires or tubes pass through the holes, such close tolerance is almost always unnecessary. Nor are close hole tolerances needed when bolts with washers on both sides are to be inserted through the holes.

In parts having multiple holes in a line, tolerances can, of course, build up over the entire piece. Where this is objectionable, the problem can be minimized by specifying all tolerances from one point rather than from a moveable dimension. With such precautions, tolerance buildup can be held within close limits, as shown in the precision switch-pusher arm, Fig. 5.

The hygroscopic nature of vulcanized fiber can

Table 5—Normal Fabrication

Thickness, (in.)	Tolerance, Plus or Minus (in.) Length or Width (in.)			
	Under 2	2-6	Over 6	
0.010-1	0.008	0.010	0.015	
94-93	0.008	0.007	0.012	
44-10	0.005	0.008	0.010	
14-1/6	0.008	0.010	0.012	

cause parts made of the material to shrink or swell, depending on moisture conditions. Thus, hole sizes can change between the time the part leaves the manufacturer and the time it is put into an assembly, and tolerance specifications of +0.002, 0.000 in. on small holes can be totally unrealistic. Some fabricators control shrinking and swelling to some extent by shipping vulcanized-fiber parts in sealed polyethylene bags, but the control ends when the containers are opened.

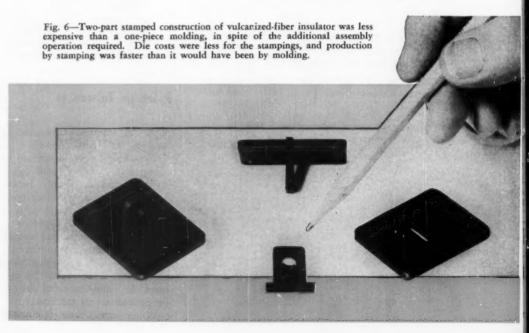
Circular parts, if punched from sheet stock, are subject to the same tolerances as punched holes and the same considerations apply in specification.

The least amount of shrinkage in vulcanizedfiber parts is in the direction of the grain. Vulcanized-fiber sheets are made wide so that the material can be cut into strips and used with the grain running either parallel or perpendicular to the cut edge, as desired.

General Applications

Flat Parts: Sheet stock costs the least of the standard forms of laminated plastic or vulcanized fiber. Stamping parts from sheet is one of the least expensive fabrication processes. For these reasons, designing a part so that it can be stamped from sheet stock (even if it requires additional pieces and an assembly operation) often produces the most economical method, Fig. 6.

Rod-shaped parts can sometimes be produced more economically from sheet than from rods, particularly parts like tuner shafts, that usually require two flat, parallel surfaces. Such parts could be fabricated by either: 1. Machining the flats on round rods. 2. Machining the round part of the shaft on flat strips cut from sheet stock. In most



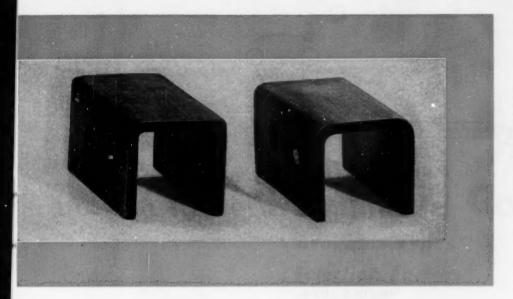


Fig. 7 — Small design change (inside radius changed from 1/16 to 3/32 in.) on shield for circuit-breaker arm permits part to be postformed from sheet, right, instead of being cut from laminate tube, left. A desirable toe-in of the sides is also incorporated into the postformed part.

cases, fabricating the shafts from strips sawed from sheet stock is the best method. First, the raw material costs much less. Second, the sheet stock has flat, parallel surfaces to begin with, and sanding of the sheet produces flats within the required close tolerances.

Tubular Parts: Specifications for tubular parts should indicate whether the part is to be made from rolled or molded tubing, or should specifically ask for recommendations of the fabricator, based on end-use information furnished.

Rolled tubing is made by convolutely winding layers of resin-impregnated base material on a mandrel. During the winding process, both heat and pressure are applied. The heat softens the resin, and the pressure insures bonding of the layers. After being finish-cured, the tubes are centerless-ground to size and may be subsequently buffed, painted, or sanded if required.

Molded tubing is made in the same general way except that the finish-curing is done in a mold under pressure. Generally, molded tubing offers better mechanical properties and moisture resistance than rolled tubing. Electrical properties of rolled tubing are usually superior to those of molded tubing because there is no mold line to provide a path of least resistance for electrical leakage. Concentricity tolerances can be held closer in rolled tubing.

Dimension specifications should be for ID and wall thickness, rather than OD and wall thickness, because the tubing is made on mandrels.

Washers: One of the most common applications for laminated plastics and vulcanized fiber is washers. Thickness of a washer has an important bearing on fabricating costs. When the wall of the washer is less than its thickness, it is called a bushing or spacer. Such parts, for best quality, should be

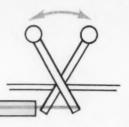
cut from tubing rather than be stamped from sheet, even though costs are greater. A way to eliminate this extra cost when thick washers (or other flat parts) are needed is to replace the thick part with two or more thinner ones. Use of thinner washers also reduces the number of thicknesses which must be purchased and stocked when considerable thickness variations are anticipated.

Shaped Parts: Beside machining, laminated plastic parts can be shaped in two other ways—postforming and molding.

Postforming is accomplished by heating the basic laminated material—usually sheet, but it can be rod or tube—to just below the blistering point (450 to 500 F), then molding to the desired shape. A fabric-base postforming grade such as NEMA Grade C is used where toughness, resilience, mechanical strength, and abrasion resistance are required; a paper-base grade such as Grade XX, where mechanical strength is secondary to low cost or good electrical properties. These postforming grades can be formed into intricate shapes, compound curves, and relatively deep draws.

One of the principal advantages of postforming is that relatively simple tooling is required. Molds can be made from metal, phenolic, hardwood, high-strength concrete, or even other laminated plastic. Metal is generally preferred because its high heat conductivity draws heat away rapidly from the piece being formed and thus speeds up cooling. The possibilities of postforming should not be overlooked, even when the shape of a part approximates a standard form of laminated plastic, Fig. 7.

Molding of laminated parts is done by a similar process as that used to make laminated-plastic sheets except that the resin-coated base materials are pressed in a mold. Usually the only machining operation required is trimming. Parts can be molded from any laminated plastic, including copper-clad and other combination laminates.



For design simplification in motion

MELVIN E. LONG

Associate Editor
MACHINE DESIGN

FFICIENT, economical transmission of motion can be provided by push-pull controls. They can transmit motion between two fixed points, or between points which are changing their relative position. These cables can be routed up, down, over obstacles, even around corners, without intermediate links or pulleys.

Typical applications range from power lawn mowers to flux-mapping of nuclear power stations.

Unlike ordinary tension cables, these controls can transmit motion in both the "push" and the "pull" directions. However, to fully utilize this two-way capability, these controls must be properly integrated into the complete design of the product.

This article describes the various types of controls, discusses their advantages and limitations, and details the design practices necessary to obtain efficient motion transfer.

Input or Output Form

Basically, all push-pull cables transmit motion by linear displacement of a cable relative to a fixed conduit, Fig. 1. The conduit may be either flexible or rigid. The input or output may be linear, arcuate, or rotary. Input and output of any one cable need not be the same type motion.

Construction

In general, control cost is a function of capacity and performance capabilities. The ideal control is one which meets, but does not unnecessarily exceed, performance demands.

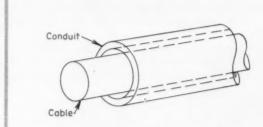


Fig. 1-Basic components of a push-pull control.

transfer . . . Push-Pull Controls

- . Available Types
- . Selection Factors
- . Design Practices

The simplest, lowest-cost controls consist of solidwire cable with a conduit of either spirally wrapped wire, Fig. 2, or a plastic encased, punched flat-wire ribbon, Fig. 3. Cable material may be spring steel or stainless steel.

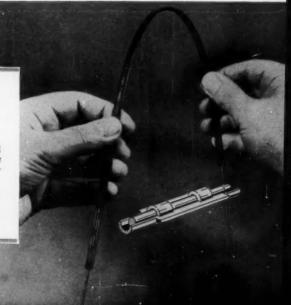
Minimum bend radii necessary to prevent the cable from taking a permanent set are proportional to cable diameter. Therefore, the load-capacity advantage of the larger cables is counterbalanced, in many installations, by the difficulties of providing adequate bend radii.

At somewhat greater cost, flexible multiple-strand cables, Fig. 4, reduce the bend-radii requirements while providing increased capacity. The cable may be



Fig. 2—Simple control composed of a solid-wire cable and a spirally wrapped wire conduit.

Fig. 3—Low-cost control composed of a solid-wire cable and a flat-wire ribbon conduit.



single or multiple-layer, depending upon the size. The conduit is normally a spirally wrapped wire, as in the simpler controls.

For maximum load capacities in relation to bend radii, two arrangements are available. In either, the cable is normally multiple strand.

However, the conduit may be of multiple-strand construction, to provide flexibility, Fig. 5, or it may be of rigid tubing.

Load Capacities

Force transmitting capacity is proportional to the diameter of the cable. Maximum recommended loads in compression are usually about 50 per cent of the maximum recommended tension loads.

The solid-wire cables are normally limited to

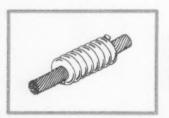


Fig. 4—Flexible multiple-strand cable and spirally wrapped wire conduit. This arrangement permits reduced bend radii.

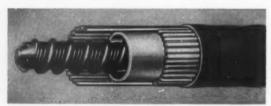


Fig. 5—Flexible multiple-strand cable and conduit. This combination permits minimum bend radii in relation to load capacity.

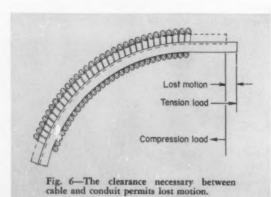


Fig. 7—A rod fastened to the multiple-strand cable provides a convenient attachment point.



about 15-lb compressive load. The multiple-strand cable and spiral-conduit controls withstand compressive loads up to 80 lb. The multiple-strand cable with multiple-strand or rigid conduit has compressive-load capacities as high as 1000 lb.

Service Life

Even though the cable is continuously flexed during operation, the loads in a properly selected cable are low enough that fatigue failure is not normally a problem.

▶ Bend Radii

Bends in the conduit must be of sufficient radius to permit the cable to "flow" smoothly without acquiring a permanent set. Minimum recommended radii may vary from 2 to 8 in., depending upon cable diameter and construction.

Bends with radii smaller than the recommended minimum values will produce excessive friction and reduce service life.

Lost Motion

The difference between input and output movement, Fig. 6, is often the most troublesome factor in push-pull control application. However, if minimum lost motion is an essential performance requirement, it can be provided by proper application techniques.

Lost motion can result both from deflection losses and backlash.

Deflection: Two factors are responsible: 1. Strain in the cable. 2. "Snaking" of the cable under compression loads,

Strain is controlled by selection of a cable of adequate diameter for the imposed load.

Snaking depends primarily upon amount and uniformity of clearance between the cable and the conduit. A minimum uniform clearance permits the minimum snaking or column-action buckling of the cable when it is under compression loads.

Backlash: The necessary clearance between the cable and conduit permits translation of the core when it is subjected to alternate tension and compression loads. Total backlash depends upon both clearance and total amount of bending.

Control specifications normally include a factor to permit determination of the expected backlash in a proposed installation. For one typical ½-in. cable, the factor is 0.0004 in, per deg of bend.

Conduit Movement: Adequate constraint of the

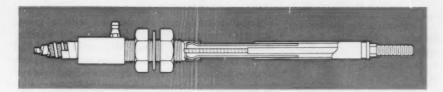


Fig. 8—Telescoping rod ends can provide up to 20 in. travel.

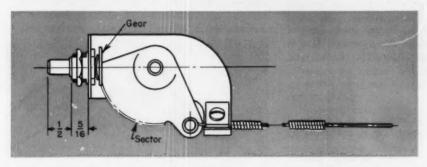


Fig. 9—Sector and gear provide rotary output motion. The cable end moves in an accurate path.

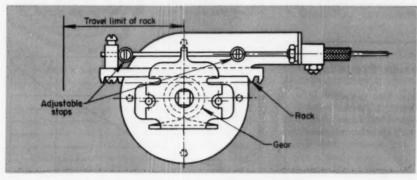


Fig. 10—Rack and gear provide rotary output motion. The cable end moves in a straight path.

conduit end pieces is absolutely essential. However, if the load rating is not exceeded, the conduit itself does not require clamping, except as needed to prevent the cable from possible mechanical damage from moving parts of the machine.

Travel Range

In the usual type application, push-pull controls have a nominal travel range of several inches, with a relatively low linear speed.

However, the higher performance controls can also transmit high-frequency oscillatory-type loads, such as those encountered in mechanical servo feedback systems. To provide maximum service life, an adjusting means should be provided for periodic relocation of the operating stroke within the total available travel range of the control.

In the solid-wire type control, linear-travel range is determined by the difference in length between the cable and the conduit. The practical limit is usually 3 to 4 in. because of the buckling tendency of the unsupported cable under compression loads.

A rod is attached to the end of the multiple-strand cables to provide a convenient attaching means, Fig. 7. The configuration of this rod and of the mounting sleeve attached to the conduit combine to determine the travel range. Normal maximum linear-travel values vary from 1 to 6 in. However, telescopic versions can provide 6 to 20 in. travel,

Fig. 8.

Normally, load capacity decreases as the travel range increases.

Angular motion of the end piece is also required if the input or output is arcuate motion.

The solid-core cable provides angular motion by simple deflection of the exposed portion of the cable. This deflection should normally be limited to 5 deg either side of the normal straight position.

In the multiple-strand cables, a swivel joint in the mounting sleeve permits angular deflection of the rod end. Maximum recommended values vary somewhat, but range from 5 to 10 deg either side of the normal straight position.

Rotary-motion output or input can also be provided. However, the cable travel is linear.

In one arrangement, a gear sector drives a smalldiameter gear, Fig. 9. The end of the cable attached to the gear sector moves in an arcuate path.

In another arrangement, a small pinion is driven by a rack, Fig. 10. Here, the end of the cable moves in a straight line.

A more sophisticated arrangement uses a hobbed gear which engages the spiral outer wrapping of the flexible cable, Fig. 11. A housing protects the gear and the cable. The extreme flexibility of the multiple-strand cable permits the use of relatively small-diameter gears.

Variations of this basic design permit the cable

to drive one or more secondary cables. The design also provides unlimited rotary motion.

Friction

Even if a cable appears to be perfectly straight there will be a nominal friction loss. The usual bends in a cable increase the friction losses. Control specifications usually include the necessary data to determine friction loss as a function of the total curvature of the cable, Fig. 12.

Lubrication

Normally, the cables are lubricated at the time of manufacture with a lubricant that is unaffected by temperature extremes.

Solid-wire cables may require periodic lubrication, but the more complex cables are usually sealed so that no further lubrication is required.

Sealed controls can be obtained with a grease fitting to permit periodic lubrication and flushing of the end assemblies. These fittings must be installed by the control manufacturer. However, the presence of these fittings often tempts the uninformed operator to over-lubricate or use improper lubricants, thus damaging the seals,



Fig. 11—Spiral outer wrapping of the cable engages a hobbed gear wheel to provide rotary output motion.

Step-by-Step Design Procedure

- I. Determine: 1. Maximum load in each direction required at output end. 2. Permissible lost motion. 3. Travel required. 4. Range of operating temperatures. 5. Other unfavorable conditions such as dust, dirt, moisture, chemical corrosion.
- II. Tentatively select a cable and make a largescale layout drawing. Use as few bends as possible, and keep bend radii equal to or larger than recommended minimum values. If this limitation cannot be met, select another cable that will tolerate shorter bends.
- III. Provide positive locating points for each end of the cable. Total length of the cable assembly can now be estimated.
- IV. Build a mock-up of the proposed installation, duplicating the relative location of the input and output ends, the load required at the output end, as well as the proposed routing and clamping arrangement.
- V. Exact cable length can be determined now. It should be just enough to provide adequate length when all the manufacturing tolerances of the machine components are combined to produce the maximum over-all length. Excess cable length necessitates extra bends which add to the lost motion and friction load.
- VI. Critical performance characteristics can be verified by equipping the mock-up with an actuating device and a means of applying a simulated load. Characteristics which should be investigated include measurement of cable friction, lost motion, and life in expected environmental condition such as dust, moisture, or corrosive atmosphere. Periodic measurements of friction and lost motion during the durability test are helpful in establishing the rate of performance deterioration.

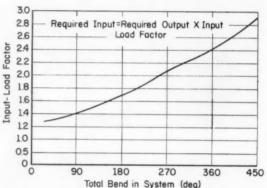


Fig. 12—Friction loss curve for a typical push-pull control.

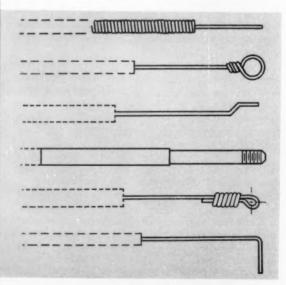


Fig. 13—Methods for attaching linkages to the ends of solid-wire cables.

End Attachments

The designer usually has a choice of several methods for attaching the motion-transmitting cable to the associated mechanisms, as well as a choice of methods for fastening the conduit ends.

Solid Cable: Straight-line or arcuate motion links can be attached to the solid-wire cables by any one of the methods shown in Fig. 13. Screw clamps, attached directly to the cable provide adjustment of their location along the cable. The other methods require that any needed adjustment be provided elsewhere in the system.

Flexible Cable: Usually, some form of a solid end is attached to the flexible cable, as shown in Fig. 14.

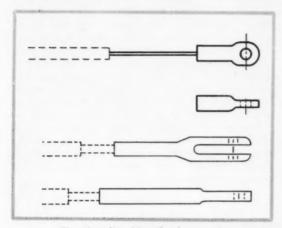


Fig. 14—Adjustable end rod on a multiple-strand flexible cable.

The threaded-rod type is adjustable, whereas the others are nonadjustable.

Conduit: The solid-wire control does not provide for extreme accuracy of location of the ends. In fact, this feature is used as a means of providing adjustment of the location of the cable travel. The control should be clamped reasonably close to the end of the conduit, however.

The more complex controls incorporate an attaching and locating arrangement in the mounting sleeve attached to the conduit, Fig. 15. The sleeve may be threaded to receive a locknut for through-panel mounting, or it may have a clamping groove for surface mounting.

If several controls terminate in a control panel, the clearance required for attaching the conduit ends should be carefully considered. Otherwise, over-all space required may become excessive.

▶ Operating Environment

To obtain satisfactory service life, the operating environment must be considered. For example, dust, moisture, heat, chemical corrosion, and mechanical damage can lead to premature cable failure,

Dust and moisture damage must be controlled by adequate sealing between the movable end pieces and the fixed sheath ends. For excessively dusty conditions, a special-design wiper seal may be required

For extreme dust or moisture conditions, a telescoping boot, Fig. 16, is available. One end of this accordion boot attaches to the rod, the other end to the fixed sleeve. This boot may require periodic replacement during the life of the machine.

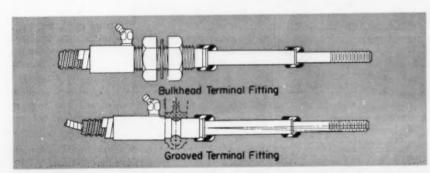


Fig. 15—Anchor points for conduit ends.

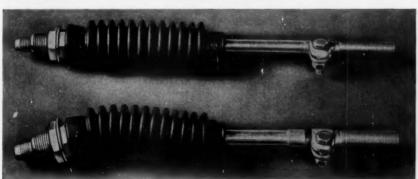


Fig. 16—Telescoping boot for protection of cable ends in extreme environments.

Chemical corrosion and heat damage are usually controlled by the choice of materials.

A flexible covering is often used over the spiralwire sheaths to provide at least minimum corrosion protection.

Mechanical damage may occur during regular use of the equipment or during overhaul or repair. The cables should be routed so that they are protected by the basic machine structure, or if this is not practical, additional mechanical protection should be provided in areas of likely damage.

If a cable must be routed across the junction of two major components which will have to be disassembled for repair or overhaul of the machine, the cable clamps and end attachments should be arranged to facilitate release of at least one end of the cable.

Cable Splices

The assembly procedure for large, complex machines may require the subassembly of components and then final assembly as a separate step. If any one control must attach to both these subassemblies, it is normally attached to one, and the free end left dangling and unprotected until final assembly. However, a cable connector, Fig. 17, permits the two portions of the cable to be installed independent-

ly. Then, during final assembly the two parts are simply hooked together.

This same arrangement also facilitates separation for the subassemblies, if required for repair or overhaul of the machine.

▶ Special Requirements

There are several special requirements or operating conditions which should be considered for each cable installation. Normally, only a limited number of these considerations will be applicable to any one installation.

Controlled Friction: Normally, special emphasis is placed upon reducing friction. However, in some special applications, it may be necessary to provide a source of controlled friction. For example, in a mechanical-feedback servo system, extra friction in the cable leading to the control lever may be required to insure that the error signal will operate the servo device rather than moving the control lever.

If the friction arrangement is located at the servodevice end of the cable, the additional load will be imposed upon the cable each time the control lever is operated. However, none of the error signal will be consumed in overcoming cable backlash.

Location of the friction device at the lever end of the cable reduces cable loads, but requires the error signal to overcome cable backlash. Whenever the error signal reverses direction, the backlash then causes inaccuracies in the servo system.

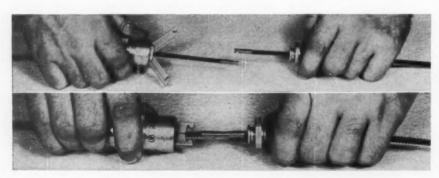


Fig. 17—Connector for splicing cable,

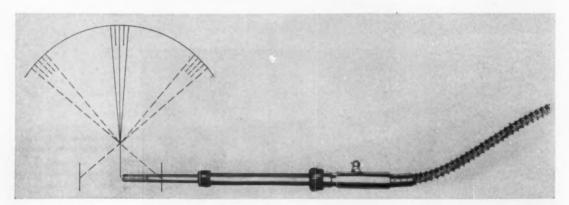


Fig. 18-Vernier adjustment permits precision positioning at any point within the normal travel range.

Fig. 19—Multiplier linkage for reducing effect of cable lost motion.

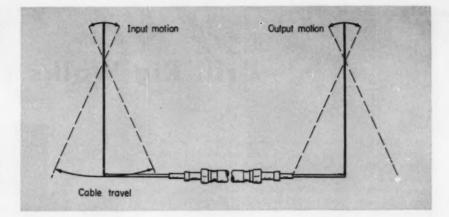
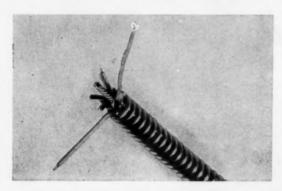


Fig. 20—An insulated electrical conductor can be provided within the multiple-strand cable.



Position Locking: If the selected position of the cable must be retained, regardless of vibration, shock, or other external influences, a positive friction lock at the input end of the cable can be used. Usually this lock is a spring-loaded clamp which grips the cable and holds it in the selected position. A quick-release device permits repositioning of the core.

Vernier Adjustment: If the cable must be precisely positioned at an infinite number of points in its normal range, a vernier adjustment should be considered.

A quick release permits linear movement of the cable to the nominal setting. The vernier is then engaged and the cable rotated to actuate a worm gear for final positioning, Fig. 18.

Cables using the hobbed-gear control box also provide vernier adjustment. No engagement or release of a vernier device is required. Linear motion of the cable rotates the hobbed gear to the nominal position; rotary motion of the cable provides vernier rotation of the gear.

Spring-Loaded Return: If absolute minimum backlash is desired, a spring-loaded return should be considered. This arrangement requires a spring strong enough to return the entire system when the input load is removed.

In effect, the push-pull control is converted to a tension cable. Load changes produce only variation in the amount of tension, rather than changes from tension to compression. Limiting factor here is the handle loads that can be tolerated by the operator. Ratio Increase: Lost motion can also be reduced as shown in Fig. 19. The input motion is multiplied by a lever to provide increased cable travel, A similar lever reduces the cable travel to an output motion comparable to the input motion.

In this arrangement, lost motion in the control assembly is a smaller proportion of the input and output motion than if the two points were connected directly.

Thermal Expansion: In many applications, variations in conduit and cable length as a function of ambient temperature change can be disregarded. However, in high-precision applications, this factor must be considered.

Electrical Conductor: Special cable assemblies are available which include insulated electrical conductors for transmission of power or control signals, Fig. 20. This arrangement can help simplify the installation if both electricity and motion must be transmitted.

External Pressure: If the control traverses pressurized compartments, both the effect upon cable operation and the effect upon compartment leakage must be considered. The conduit must be strong enough to resist the squeezing effect which would increase operating friction.

Any pressure leakage through the conduit into the clearance around the cable will reduce the effectiveness of the cable-to-conduit seals at the end pieces.

ACKNOWLEDGMENT

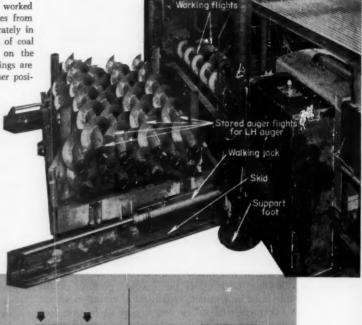
Machine Design acknowledges with appreciation the cooperation of these companies in the preparation of this article:

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(Fig. 6, 7, 8, 12, 15, 18) Detroit, Mich.
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Weatherhead Co Fort Wayne, Ind.
Western Controls Corp Wichita, Kan.

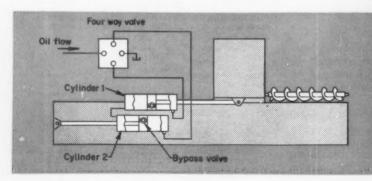
Drill Rig Walks to Work

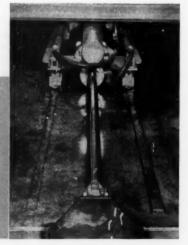
COAL VEINS too thin for conventional mining are worked profitably by a dual coal auger that bores parallel holes from 18 to 30 in. high and up to 150 ft long. It bores accurately in veins only 3 in. thicker than the auger diameter. Size of coal pieces removed is controlled by changing drill heads on the front of the auger. After a hole is completed, auger strings are withdrawn and stacked and the machine walks to another position to start a new hole.

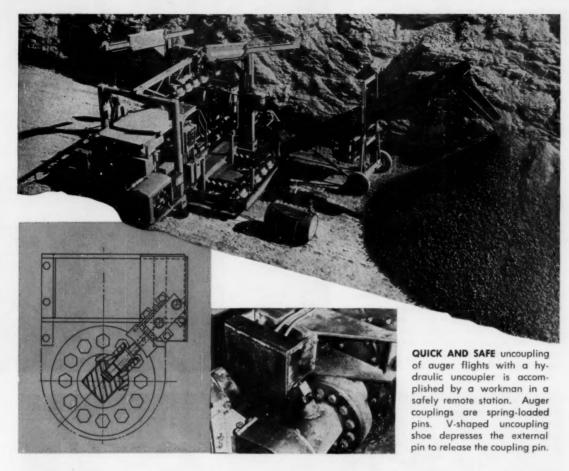
support FEET are raised or lowered hydraulically to level the rig during the drilling operation. To move to a new site, the rig is lowered to the skid and the support feet are lifted off the ground. Walking jack is a long hydraulic cylinder that is contracted to pull the rig along the skids. In the new location support feet are lowered, and the rig is lifted to working height and leveled. Skids are extended in preparation for the next step. Independent control of forward and rear walking jacks is used to turn the rig or follow the contour of a hill.



DIFFERENCE in areas between rod side of piston and free side is used as cushioning factor in double-extension carriage piston. For uniform speed during most of the carriage travel, both pistons operate simultaneously at a slightly different rate of speed. Areas on rod sides of pistons are 4/5 as large as free areas. Therefore, when cylinders are extending, cylinder 2 moves 4/5 as fast as cylinder 1. When cylinder 1 has completed its travel, cylinder 2 has 1/5 of its linear range left to go. This last 1/10 of total carriage travel proceeds at approximately 1/2 speed, since the fluid is moving only one piston.



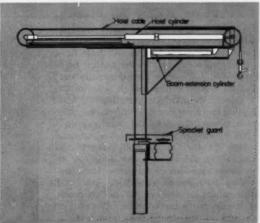




COUNTERROTATING AUGERS keep flow of coal uniform. Previously used same-handed augers tended to drive loose coal to one side, causing the clogged auger to climb and distort the boring contour. The new system keeps flights in line, makes cleaner cuts, avoids breaking out of coal vein on close cuts. Cutting heads can be replaced by others with different bit spacing to vary the size of coal chunks removed. Wedges break out the web between individual round bores leaving an oval hole in the hill.

EXTENSIBLE BOOMS on the flight hoists are a space-saving feature that allows the hoists to be operated from a post set closer to the machine than otherwise possible. The boom extends as the hoist swings out to pick up an auger flight, and retracts as the flight is swung into position ahead of the carriage. Boom-extending cylinder and boom-rotating hydraulic motor operate simultaneously; a standard flow-dividing valve splits the hydraulic flow between them. **Development** of the dual-augered machine was directed by Charles Govin, Salem Tool Co.'s chief engineer. Special hydraulic features were built for Salem by Commercial Shearing and Stamping Co., Youngstown, Ohio, who provided standard hydraulic pumps, valves, and cylinders for the machine as well.

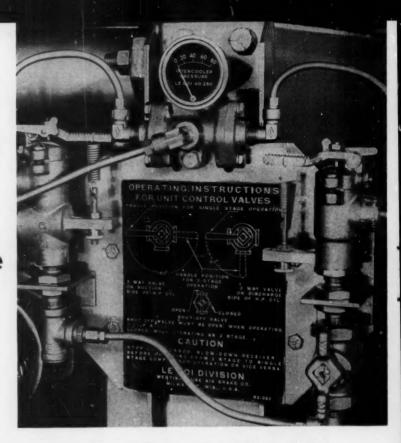


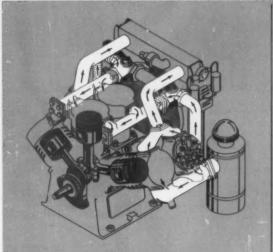


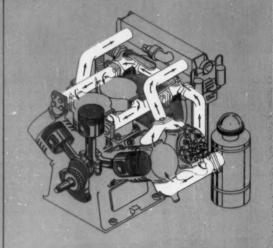
May 11, 1961

Manifold Valves Change Compresser Operating Mode

ETTHER low-pressure, high-volume or high-pressure, low-volume output can be produced by a new air compressor that changes air flow pattern to and from cylinders. In the high-pressure mode of operation, air from the side cylinder banks is fed to an intercooler and then to the center bank which operates as a second-stage compressor. In the low-pressure mode, all cylinders operate in parallel. Air from the side banks still passes through the cooler, which then functions as an aftercooler.



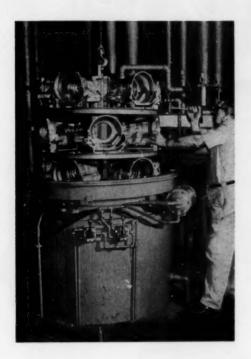




ADJUSTMENT of two valves changes mode of operation of the compressor. Air from filter in the foreground supplies the nearest bank of cylinders. The other two banks are supplied by a similar filter out of sight on the far side of the machine (note flexible hose coupling for center bank). Air from the outer banks always flows to the head manifold of the intercooler. Air leaves the manifold through the riser to the right. Right-hand valve either directs it to the outlet, or to the intake manifold of the center bank, depending on mode of operation. Left-hand valve selects atmospheric air or intercooler air for the center-bank intake. Outlet is at the end of the center-bank manifold.



DUAL-STAGE compressor with six cylinders can deliver air at 50 or 125 psi. Displacement ranges from 548 to 1080 cfm at speeds from 870 to 1250 rpm. Power requirements range from 105 to 175 hp. A three-cylinder model is also made. Dual-mode compressor was developed by Le Roi Div., Westinghouse Air Brake Co., Sidney, Ohio.



Speed and Safety Built into Sealing Unit

SALVAGING leaky castings for parts that are supposed to be water or oil tight calls for impregnating them with a sealant. The sequence of vacuum, pressure, and high temperature needed to do the job presents hazards to the operator. An interlocking two-step control system safeguards the operator against most of these perils, while furnishing the accuracy and repeatability of sequence controls to the treatment process.

Cycle Sequence

(time: 22 min, 24 sec)

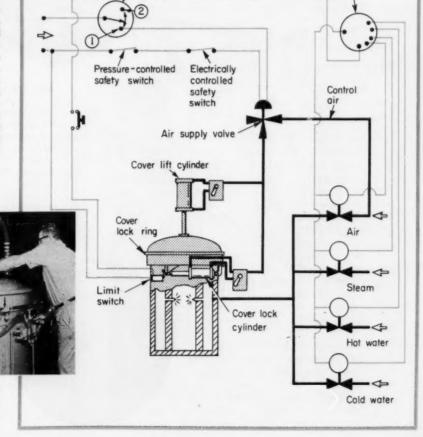
Cycle relay

- Draw vacuum
 Admit sealant
 Apply air pressure
 Return sealant; vent
 autoclave
 Cold-water rinse; apply air
- 6. Agitate; dump cold water 7. Hot-water rinse; apply air 8. Agitate; return hot water 9. Admit steam spray; vac-
- uum dry 10. Vent autoclave

Programmer

and timer

CYCLE RELAY divides manual and automatic operations. Interlocks prevent either cycle from starting until the other is complete. Cover-lift and cover-lock cylinders cannot be operated while the cycle relay is in position 2. Pressure and electrical safety switches form a double check on conditions for opening. In the same way, the automatic cycle cannot be started until the cover-lock ring closes the limit switch.



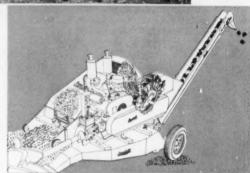
Programmed impregnation system was developed by Prenco Mfg. Co., Royal Oak, Michigan.

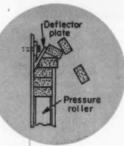


design in action

Ring Die Makes Hay Biscuits in the Field

EXTRUDED HAY BILLETS that are easily handled or stored and don't need baling wire or string to hold them together spew out of a tractor-drawn nay waferer. It scoops up windrowed hay and produces the wafers at the rate of 5 or 6 tons per hour. Power for the machine comes from a 56-hp engine mounted on the frame. PTO from the tractor gives added power. An overrunning clutch lets the PTO start the waferer's engine. The field wafering machine, developed by Lundell Manufacturing Co. Inc., Cherokee, Iowa, comes with two powerplants: The 125-hp model (above) needs no auxiliary power from the tractor. The 56-hp model (right) uses the PTO system.





Pressure rollers

Pressure rol

RING DIE receives crushed hay forced into its chambers by the pressure rollers and extrudes hay pellets that are broken off by deflector plates. Pressure in the forming chambers is controlled by hydraulic density regulators—pressed against the hay to maintain desired density. Hydraulic cylinders are manifolded to maintain equal pressure on all chambers. This helps make uniform pellets in spite of variations in moisture and fiber content. Conditioning equipment includes a blower which delivers hot air from the engine compartment to help dry formed pellets, and a mois-

ture tank to precondition too-dry hay. Best moisture content has been found to be between 14 and 18 per cent. Water can be used as a moisturizing agent, but molasses solutions minimize drying problems Solution is sprayed on the hay as the feed auger turns it, thus producing uniform wetting.

A design guide

Preventing Fatigue Failures

Fatigue failures often start at geometric stress concentrations — holes, threads, surface flaws, etc. The trick is to reduce or eliminate them —or to design to accommodate them.

Part 2 — Geometric Stress Concentrations

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H. N. CUMMINGS
Consulting Engineer

W. C. SCHULTE Chief Metallurgist

Propeller Div. Curtiss-Wright Corp. Caldwell, N. J. A LOCAL surface stress significantly higher than the stress at adjacent points is the unhappy result of an abrupt change in the geometrical continuity of a structural component. Holes, notches, threads, and rough machine marks are examples of geometric stress concentrations.

The ratio of maximum stress at the discontinuity in a perfectly elastic material to the uniform stress in the adjacent area is called the geometric or theoretical stress-concentration factor. This factor is also defined as the ratio of the maximum stress at the discontinuity to the nominal stress at this point based on common engineering formulas. The geometric stress-concentration factor is usually determined by precise theoretical stress analysis or by photoelastic tests.

Almost all fatigue failures are caused by stressconcentrators, sometimes called stress-raisers or notches. Consider a specimen of absolutely homogeneous material, of uniform circular cross section, and loaded by uniform bending, twisting, or axial force. Under these conditions, fatigue failure would probably start simultaneously at all points on the surface, and disintegration would progress uniformly toward the axis. On the other hand, any deviation from a perfectly circular cross section is a geometric stress concentrator, and will cause the stress flow-lines to change their density. This increases the stress and localizes the region in which fatigue failure is likely to begin. Fatigue failures always start at one or more localized regions.

Structural material, which is usually polycrystalline, is made up of crystals that differ moderately in size and widely in orientation. Even if the crystals were of absolutely uniform chemical composition, their planes of weakness (slip) would still vary in direction, or orientation. Moreover, no specimen can be made absolutely perfect in shape and size. In every design, then, there is at least one spot where the stress intensity will be higher than in the general neighborhood. If this concentrated fatigue stress is too much for the material, a fatigue crack is initiated and may grow until the part fractures. These regions of fatigue-failure initiation are often so small that they can only be measured under high magnification. In the design of structures that must withstand essentially steady loads, stress concentrations caused by changes in section, or by notches, holes, etc., can sometimes be ignored, since low-strength alloys are sufficiently ductile to compensate for these concentrations. Stress concentrations simply cause the metal to yield locally, thereby readjusting the stresses at and around critical points. However, this situation does not exist when the oscillatory or vibratory loads are applied to the structure. Since the fatigue limit of an alloy is always below its gross yield point, the metal cannot yield at the critical points to readjust the stresses.

▶ Stress-Concentration Factors

Various stress-concentration factors are used in determining or predicting fatigue failure in materials. These factors have been evaluated for most of the common discontinuities, and comprehensive summaries of these data have been published.¹

Geometric or Theoretical Stress-Concentration Factor: This factor, K_t , is the ratio of the elastic stress

References are tabulated at end of article.

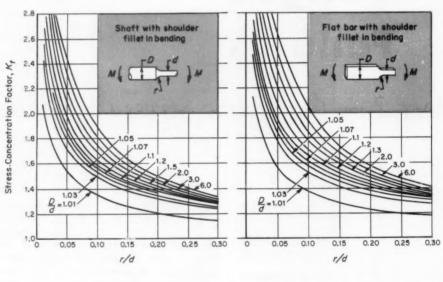
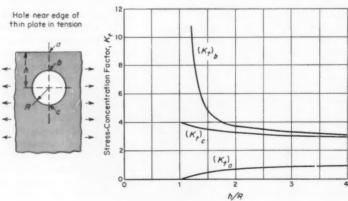
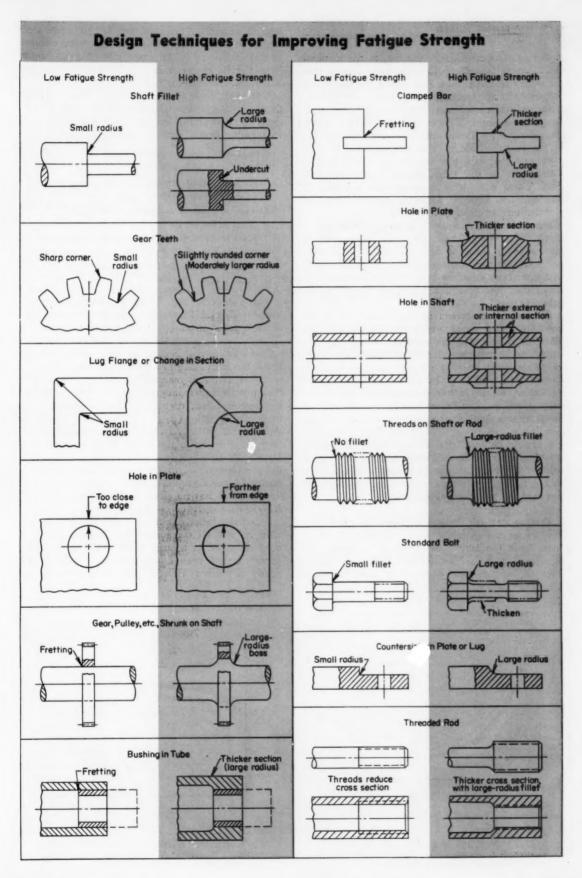


Fig. 6 — Typical curves for finding K_t under various conditions.^{6, 7} Extensive collections of these graphs are available.





at the point of stress concentration, to the nominal elastic stress (assuming no stress concentration) at the same place. Although K_t is called the theoretical or geometric stress-concentration factor, truly theoretical expressions are available for only a few relatively simple cases. Typical of these are the expressions derived by Timoshenko² for stress distribution in the neighborhood of a small circular hole in a plate subjected to a uniform tension, and for stress distribution in the neighborhood of an elliptical hole. These derivations assume static stressing of homogeneous, isotropic, perfectly elastic material in plates of uniform thickness.

For notches with straight or sloping sides and a small radius at the base, the work of Neuber³ is currently the standard basic reference. This work presents analytical expressions for the value of K_t that have been found to be quite reliable where the notch does not deviate a great deal from the as-

sumed shapes.

For such stress-raisers as short-radius fillets, oil holes in shafts, notches of other than circular or elliptical shape, etc., the mathematics are too involved to be practical. Experimental methods such as photoelastic analysis on materials of approximately ideal character have been used to obtain data that, although not exact, are usable. These values, experimentally determined, are usually quoted as K_t , the theoretical or geometric stress-concentration factor.

It should be noted that K_t depends on the geometry of a statically stressed part, and on the type of load.^{1, 4, 5} Typical graphs for values of K_t are given in Fig. 6. A comprehensive collection of these graphs has been put together by Peterson.¹

Fatigue Strength Reduction Factor (Notch Reduction Factor): This factor, K_f , is the ratio of the fatigue limit (or fatigue strength) of an unnotched structural part to the fatigue limit (or fatigue strength) of the same part with a notch.⁶ Fatigue

limit is defined as the maximum fatigue stress that can be applied an infinite number of times without causing failure. Fatigue strength is the maximum fatigue stress that can be applied a given number of times without causing failure.

Unlike K_t , K_f is affected by many of the variables that affect fatigue strength, in addition to the geometry of the part and of the notch. It has been shown,⁵

for example, that K_f seems to vary with:

- 1. Geometric stress-concentration factor
- 2 Material
- 3. Hardness (tensile strength) of metal, Fig. 7
- 4. Residual stresses at base of notch
- 5. Type of stress-direct, shear, or both, Fig. 7
- 6. Grain size of metal
- 7. Stress levels of both vibratory and/or steady stress
- 8. Temperature
- 9. Notch form, especially for severe notches
- 10. Other possible variables

The curves in Fig. 7 indicate little correlation between K_f and tensile strength, and between different types of stressing.

Notch-Sensitivity Factor: In recent years an attempt has been made to establish a parameter which would rate various materials according to how well they maintain their fatigue strength when weakened by a stress raiser, or notch. The parameter⁰ used most often is $q=(K_f-1)/(K_t-1)$, where K_f and K_t are, respectively, the fatigue-strength reduction factor and the theoretical stress-concentration factor, Fig. 8.¹⁰ This factor is an index of the sensitivity of a material to the effect of a notch in reducing fatigue strength. If $K_f=1$, then q=0; that is, the notch has no effect on the fatigue strength. If $K_f < K_t$, q < 1. If $K_f = K_t$, q = 1.

Sensitivity factor q, although useful, is no stronger than its weakest component, K_f . Values of q have been examined in a large number of rotating-beam tests.¹¹ It has been found that these values vary nearly as much in different tests on one material as

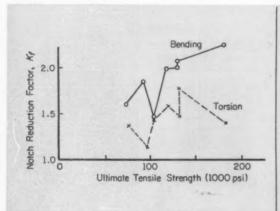


Fig. 7—Variation of K, with ultimate tensile strength for seven steels. Data were obtained for specimens in bending and in torsion.⁸

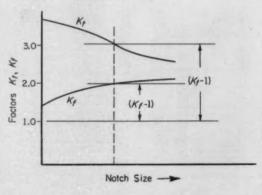


Fig. 8—Graphical representation of notch-sensitivity factor q. The value of q depends on the size of the notch or on some other variable. ¹⁰

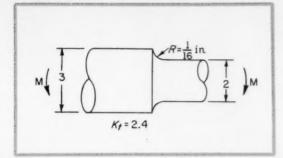


Fig. 9—Stepped shaft, showing a fillet at the change in section. If the fillet were changed to $R=\frac{1}{4}$ in., K_i would drop to 1.6 and fatigue life would be increased.

they do on different materials. There seems to be no systematic variation of q with hardness, yield point, or yield ratio.

Recently, fairly extensive tests seemed to indicate a correlation between the sensitivity and hardness of steel. Tests on specimens of a tool steel (18 per cent tungsten, 4 per cent chromium, 1 per cent vanadium) indicated that notch sensitivity decreases when the hardness increases above 400 (Vickers).12 Values of q from tests on air-melted SAE 4340 steel¹³ with the same notch root radius seemed to verify that conclusion. However, when data on vacuummelted SAE 4340 steel became available, similar computations showed no decrease in q for increased hardness. Actually, the notch fatigue strengths of the two steels were essentially the same, but the smooth strength of the vacuum-melted steel was improved by a reduction in inclusion content, so that $(K_t - 1)$ was not lessened by increased hardness, as it had been for air-melted steel.

Minimizing Stress Concentrators

For many of the common stress-concentrators, K_t can be kept to a minimum, even if it cannot be eliminated. For example, the 0.0625-in. fillet radius in Fig. 9 might be increased to 0.250, unless this would interfere with another component. This increase in the size of the fillet radius would cause K_t to drop from 2.4 to 1.6. This reduction in K_t is especially important, since nominal stresses at the fillet radius must be multiplied by the proper value of K_t for the fillet. In addition, there may be other stress-raisers to be taken into consideration such as the one illustrated in Fig. $10.^{14.18}$

Critical stresses can be held down by modifying the size or the shape of stress-causing discontinuities, as shown in the accompanying chart. All of the suggested changes have been found to increase the fatigue life of structural parts. In most cases, it was possible to make the change great enough to eliminate failures at the redesigned section.

In most of the cases illustrated in Fig. 11 there are no available values of K_t , and the designer is forced to estimate K_t . In this case, knowing how lines of stress flow by a discontinuity helps in arriving at an accurate estimate of K_t .

Stress raisers may also be caused by improper methods of fabrication or handling. This may in-

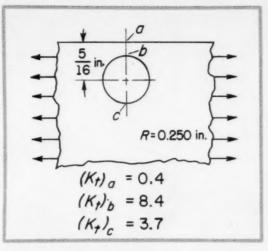


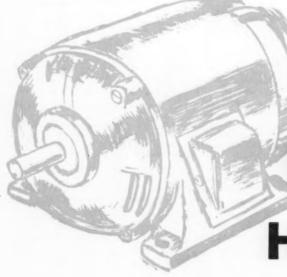
Fig. 10—Hole in a thin plate showing values of K_t at several points. If distance *ab* were increased to $\frac{1}{2}$ in., values of K_t would increase to $(K_t)_e = 0.8$, but $(K_t)_b$ would decrease to 3.8, and $(K_t)_c$ to 3.3.

clude such things as file marks, inspection stamps, grinding cracks, a decarburized surface layer, an undercut beside a weld (resulting from melting of parent metal), an unfused spot in a weld, an accidental bruise, a burr or fin left from grinding, etc. Either some stress increase must be accepted, or the causes must be eliminated by carefully written specifications, proper manufacturing techniques, and proper inspection procedures.

Part 3 will discuss metallurgical stress concentrations—those caused by nonhomogeneity of the material.

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How to specify

Fractional-Horsepower Motors

Part 1: Electrical Considerations

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Fig. 1-Nameplate with required motor data.



ARLY delivery and minimum cost are two primary advantages obtained by specifying standard, rather than special, fractional-horsepower electric motors, Reasons include the availability of multiple sources of supply and the elimination of charges for stocking special parts or for extra engineering of units.

Normally, specifications for fractional-horsepower motors include a description of available power supply, intended and projected use, duty cycle, space limitations, and ambient conditions. Based upon this information, a supplier selects the simplest motor available to permit fast delivery and to eliminate the cost of features or capacity that are not required.

But, if some application detail is overlooked, the motor furnished may fail to perform satisfactorily on the job even though it meets the original specifications. Specially engineered designs may fail also as a result of incomplete information, and here the cost is much greater.

By contrast, careless planning or analysis may result in too much information. Unnecessary restrictions may call for a special rather than a standard motor or combination of standard parts.

Often, a poor choice of motor is made simply because of lack of information on:

- 1. What is standard?
- 2. What is readily available?
- 3. What can be offered different from standard but with a minimum penalty in time and expense?

Standards for fractional-horsepower motors have been established by National Electrical Manufacturers Association (NEMA). These standards, NEMA Standards Publication MG 1-1959, Motors and Generators, cover both electrical performance and mechanical configuration and are quite complete. Fortunately, many manufacturers have adopted them. These standards serve as a guide for the user as well as the manufacturer. Consequently, throughout this two-part series references to paragraphs in NEMA MG 1-1959 will be inserted to indicate where additional information on a subject can be found.

This series, then, covers information that is necessary for proper specification of fractional-horsepower motors. Motor features and performance are described and related to basic industry standards.

Table 1-System and Motor Voltages

	- Motor Voltage				
System Voltage* (v)	Single Phase†	Polyphase (v)			
120	115t	110			
120/208 Y	1151	208-2201			
240	2301	2201			
480	-	4401			
600	-	5501			

*Voltages are preferred nominals for standard U. 8. alternating current.

†Single-phase, single-speed, capacitor-start motors rated at 1/3 hp and above usually have dual voltage ratings.

‡For 380 v. 60 cycles. 3 phase, a 220/380-v rating is recommended. For 380 v. 50 cycles, a standard 440-v 60-cycle rating may be used.

‡Standard voltage ratings.

Reference: NEMA MGI-1959, Par. 2.01.

Nameplate Data

The minimum information required on motor nameplates is outlined by NEMA (MG 1-2.16), Fig. 1. Because the same motor may be used in many different applications, nameplates are reserved for information that specifically applies to the motor. "Nonmotor" details should not be included on the nameplate.

Voltage: Standard motor voltages are listed in Table 1. To avoid confusion, standard voltage of the equipment, rather than system voltage, should be shown on the nameplate. Motors are designed to operate satisfactorily on plus or minus 10 per cent of the voltage indicated on the nameplate. Performance changes only slightly within this range, and motor life does not suffer.

Power: Nameplate power is based on breakdown torque using NEMA rating tables (MG 1-2.07). Values in these tables allow for differences in manufacturing techniques and in specific design standards.

Frequency: Fractional-horsepower motors are de-

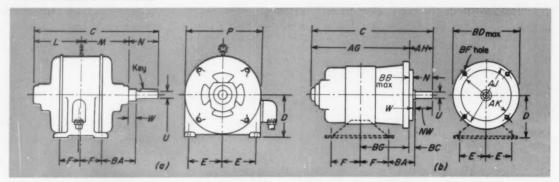


Fig. 2—Outlines and dimensions of, a, foot-mounted and, b, Type C face-mounted fractional-horsepower motors. Dimensions D, M, N, and P are not standardized. Because NEMA 48 or 56 frames have no shaft shoulder, dimension BA is to the end of the bearing hub. (NEMA MG 1-1959: Part 3, Fig. 1 and 3b; Par. 3.10.)

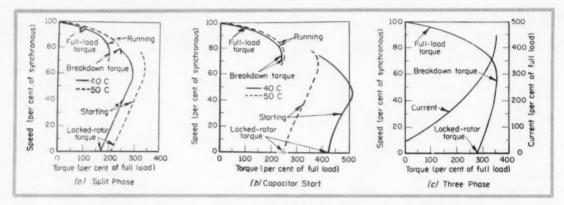


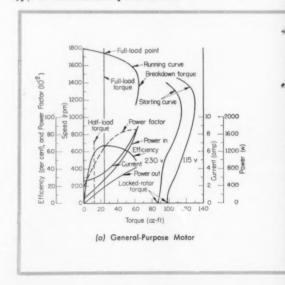
Fig. 3—Speed-torque curves for three typical fractional-horsepower motors. Data for a are: At rated 40-C rise—115 and 230 v, 60 and 50 cps, moderate starting current and torque; at rated 50-C rise—115 and 230 v, 60 and 50 cps, high starting current, moderate starting torque. Data for b are: At rated 40-C rise—115 and 230 v, 60 and 50 cps, moderate starting current, very high starting torque; at rated 50-C rise—115 and 115/230 v, 60 cps, moderate starting current, moderately high starting torque. Data for c are: At rated 40/50-C rise—208-220/440 and 550 v, 60/50 cps, normal starting current and torque.

signed to perform satisfactorily within a plus or minus 5 per cent frequency range. Frequency variation is seldom a problem. However, operation of a 60-cycle motor on a 50-cycle source, or vice versa, is not unknown. Motor operation at other than nameplate frequency requires careful investigation of the effect on performance and life.

Speed: Standard speed ratings for various power ratings and frequencies have been established by NEMA. Tables in Par. MG 1-2.06 also give corresponding synchronous speeds. However, recommended full-load speeds are only approximate, and full power may not be developed at the exact speed listed. While experience and design limiting factors have determined the nameplate speeds, the speed selected must agree with the NEMA standards.

Service Factor: For motors which have a rated temperature rise of 40 C continuous duty, the service factor is a multiplier which is applied to rated horsepower to indicate maximum permissible loading, Table 2. When a motor operates at this allowable

Fig. 4—Typical performance curves for different types of fractional-horsepower motors.



overload, it has a greater temperature rise and may have different efficiency, power-factor, and speed than at rated load. However, locked-rotor torque and current, and breakdown torque, remain unchanged. Also see MG 1-6.06.

Classifying Methods

Motors may be classified in several ways, yet no one method necessarily gives a complete picture. Three basic descriptions are covered here. Motors may be classified also by performance or electrical type. However, these methods will be discussed in separate sections.

Application: A general-purpose motor is any open motor that has a continuous 40 C rating. Mechanical construction and operating characteristics conform to established standards. Such a motor is suitable for operation under usual service conditions and is not restricted to a particular application or type of application. Also see MG 1-1.05.

A definite-purpose motor is similar to a generalpurpose motor but is designed for use under service conditions other than usual or for particular applications. For example, performance of an openconstruction motor and its enclosed version is similar, but the enclosed motor has no service factor. Also see MG 1-1.06, MG 1-1.08.

A special-purpose motor has special operating characteristics, or special mechanical construction, or both. It is designed for a particular application and does not fall within the definition of a general-purpose or definite-purpose motor. For example, a special-purpose motor can be designed electrically and mechanically to satisfy a particular application. Also see MG 1-1.09.

Power: The range of fractional-horsepower motors extends from 1/20 hp at 1140 rpm to 1 hp at 3450

rpm. Motors within this range are usually supplied as single-phase and polyphase squirrel-cage induction motors. The basis for determining power rating is given in Tables 3 and 4. Motors of less than 1/20 hp are called subfractional-horsepower motors.

Physical Size: The most common frame sizes for fractional-horsepower motors are NEMA 48 and 56. Some manufacturers still supply fractional-horsepower motors in NEMA 66 frame sizes (having 4½ in. shaft height.) However, only NEMA 48 and 56 frame sizes are covered here, Fig. 2 and Table 5.

▶ Performance

Motor performance is usually presented as a curve plot of speed versus torque. Basic curves, Fig. 3, indicates the torque developed by a motor at any given speed from its starting point, past the full-load point, to a theoretical zero-torque point.

Important points on a speed-torque curve are:

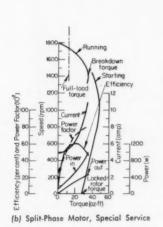
- Full-load torque—the point at which rated power is developed when rated voltage is applied to the motor.
- Breakdown torque—the point at the "knee" of the curve where any additional load torque causes the motor to decelerate rapidly.
- Locked-rotor torque—the initial torque available when the motor is energized at standstill.

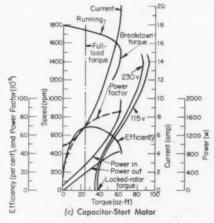
After breakaway, the motor accelerates along the

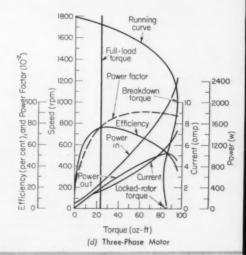
Table 2—Service Factors for Ac Motors*

Power (hp)	Service Factor
1/20, 1/12, 1/8	1.4
1/6, 1/4, 1/3	1.35
1/2, 3/4	1.25

*Values are for motors having a rated temperature rise of 40 C when operated at rated voltage and frequency. Reference: NEMA MG 1-1959, Par. 4.16.







starting curve to a speed at which load requirement and motor output are matched. At this load point, motor operation becomes stabilized. With single-phase operation, Fig. 3a and b, acceleration on the starting curve stops at approximately 75 per cent of synchronous speed. Here, a centrifugal mechanism removes the starting winding from the electrical circuit. The motor then accelerates along the running-speed curve.

On motor performance curves, the point of operation is determined by the intersection of the load curve of the driven unit with the speed-torque curve of the driving motor. To facilitate correlation of performance information, motor and load data should be based on some common standard. Motor data are tabulated at standard conditions with respect to ambient temperatures, the usual reference point being 25 C (78 F). With only mild control, close proximities to this standard temperature can be maintained. A few degrees variation does not appreciably affect test results or calculations.

Performance curves in Fig. 4 are for motors operating "cold" at approximately 25 C. As the motor warms up under load, performance characteristics change. (For example, the speed curve drops slightly.) Thus, if motor performance is unsatisfactory, the available "hot" data cannot be compared directly with the standard cold-data curves. Consequently, motor manufacturers often require cold data for a proposed application for comparison with the standard motor curves.

Cold data for a motor are obtained by tabulating all inputs and speed before the motor warms up, usually within 30 sec after energization. A reading of watts input is best for determining an operating point on the curve. Measurements of current

are not as reliable because current flow between two production motors may vary more than watts input. Checking current flow against nameplate values is even less valid because nameplate current is at best a compromise between design values and production variations.

An example of the information that can be obtained from a performance curve is illustrated for Fig. 4a. At full-load, approximate values for torque and power output are 24 oz-ft and 373 w. The torque curve is representative of production motors of the same model and type but is not a guarantee of performance for any one motor. Data at the service factor or other loads can be scaled off the performance curves by multiplying full-load ouput in watts by the desired value. For example, at ½ load the power output is ½ (373) = 186.5 w. A vertical dashed line is drawn through this point on Fig. 4a. Full-load data, and ½-load data from the intersection of the dashed line with the performance curves, are given in Table 6.

Power output is determined from

$$P = \frac{TS}{16(5250)}$$

where P = motor power, hp; T = torque, oz-ft; S = speed, rpm. Thus,

$$P = \frac{24(1735)}{16(5250)} = 0.496 \text{ hp}$$

Full-load output watts for a $\frac{1}{2}$ -hp motor should be $(\frac{1}{2} \text{ hp})(746 \text{ w/hp}) = 373$, which is the approximated value read from the curve in Fig. 4a.

▶ Motor Types

Fractional-horsepower motors are frequently classified by electrical type. Characteristics and per-

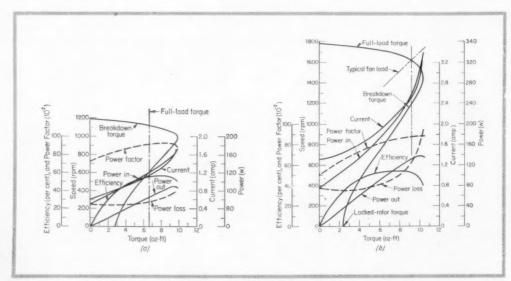


Fig. 5—Typical performance curves for permanent-split capacitor, fractional-horsepower motors. Data for a: 6 poles, 1/12 hp, 115 v, 60 cps, 5 mfd/236 v capacitor. Data for b: 4 poles, 1/8 hp, 115 v, 60 cps, 4 mfd/330 v capacitor.

Table 3—Breakdown Torque for Single-Phase Induction Motors*

Number of Poles Frequency (cps) Synchronous Speed (cpm) Rated Speedt (cpm)	80 3600 3450	2 50 3000 2850	60 1800 1725	4 50 1500 1425	0 60 1200 1140	8 50 1100 950	8 60 900 850
Motor Ratings (hp)	Breakdow	Torquet (oz-f)	1)				11246
1/20	2.0-3.7	2.4-4.4	4.0-7.1	4.8-8.5	6.0-10.4	7.2-12.4	8.0-13.5
1/12	3.7-6.0	4.4-7.2	7.1-11.5	8.5-13.8	10.4-16.5	12.4-19.8	13.5-21.5
1/8	6.0-8.7	7.2-10.5	11.5-16.5	13.8-19.8	16.5-24.1	19.8-28.9	21.5-31.5
1/6	8.7-11.5	10.5-:3.8	16.5-21.5	19.8-25.8	24.1-31.5	28.9-37.8	31.5-40.
1/4	11.5-16.5	13.8-19.8	21.5-31.5	25.8-37.8	31.5-44.0	37.8-53.0	40.5-58.0
1/3	16.5-21.5	19.8-25.8	31.5-10.5	37.8-48.5	44.0-58.0	53.0-69.5	58.0-77.0
1/2	21.5-31.5	25.8-37.8	40.5-58.0	48.5-69.5	58.0-82.5	69.5-99.0	
3/4	31.5-44.0	37.8-53.0	58,0-82.5	69.5-99.0			
1	44.0-58.0	53 0-69 5					

*Ratings do not include shaded-pole and permanent-split capacitor motors. (See Table 4.)
†These approximate full-load speeds are standard values.
Horsepower rating of motors designed to operate on two or more frequencies is determined by the torque at the highest difference.

Range of hreakdown torque includes the higher figure down to but not including the lower figure.

Reference: NEMA MG 1-1959, Par. 2.07.

Table 4-Breakdown Torque for Single-Phase Shaded-Pole and Permanent-Split Capacitor Induction Motors

Number of Poles Frequency (cps) Synchronous Speed (rpm) Shaded-Pole Motor, Rated Speed* (rpm) Permunent-Sulit Connector	4 60 1800 1550	4 50 1500 1300	6 60 1200 1050	6 50 1000 875	8 60 900 800
Motor, Rated Speed* (rpm)	1625	1350	1075	900	825
Motor Rating+ (hp)	Breakdown To	rquef (oz-ft)			
1/20	3.20-4.13	3.80-4.92	4.70-6.09	5.70-7.31	6.20-8.00
1/15	4.13-5.23	4.92-6 23	6.09-7.72	7.31-9.26	8.00-10.1
1/12	5.23-6.39	6.23-7.61	7.72-9.42	9.26-11.3	10.1-12.4
1/10	6.39-8.00	7.61-9.54	9.42-11.8	11.3-14.2	12.4-15.8
1/8	8.00-10.4	9 54-12.4	11.8-15.3	14.2-18.4	15.5-20.1
1/6	10.4-12.7	12.4-15.1	15.3-18.8	18.4-22.5	20.1-24.6
1/5	12.7-16.0	15.1-19.1	18.8-23.6	22.5-28.3	24.6-31.0
1/4	16.0-21.0	19.1-25.4	23.6-31.5	28.3-37.6	31.0-41.0
1/3	21.0-31.5	25.4-37.7	31.5-47.0	37.6-56.5	41.0-61.0
1/2	31 5-47.5	37.7-57.3	47.0-70.8	56.5-84.8	
3/4	47.5-63.5	57.3-76.5		77.7	

*These approximate full-load speeds are standard values.

†Horsepower rating of motors designed to operate on two or more frequencies is determined by the torque at the nest rated frequency.

‡Range of breakdown torque includes the higher figure down to but not including the lower figure.

Reference: NEMA MG 1-1959, Par. 2.07.

Table 5-Dimensions of Foot and Face-Mounted Motors*

NEMA Frame	-		Dime	nsion	1115		-		Key -	
No.	D	E	F	BA	N-W	U	Width	Thi	ekness	Length
48	3	236	1%	214	136	14	-	13.	flat	-
56	316	218	1%	2%	1%	96	*		ñ.	1%
	A	н	AJ	AK	BB		BG	W		Hole —
				-		-				
56C	2	la l	5%	41/2	na ma	IX.	410	%	4	%-16

*See Fig. 2 for location of letter dimensions. fLength refers to effective length of keyway. Length tol-ance of key is 52-34 in. All dimensions are in inches.

formance of the more common polyphase and singlephase motors are covered here.

Polyphase Motors: Both two-phase and threephase motors are included here. These motors have a separate set of windings for each phase of the polyphase circuit. Because of the available phase difference, the auxiliary or start winding that is required for single-phase motors is eliminated.

Fractional-horsepower motors, generally, have

Table 6-Motor Performance Data

1735 1765	550 310	373 186.5	2.6 2.9	65.5 45.5	67.5 59.5
	1765		1765 310 186.5	1765 310 186.5 2.9	1765 310 186.5 2.9 45.5

only one type of performance-NEMA Design B. Polyphase performance can be altered by a change in rotor design, but this is not a common practice. Because of the drooping characteristics of NEMA Design B, a polyphase motor which produces the same breakdown torque as a single-phase motor cannot attain the same speed-torque point for full-load speed as a single-phase motor. Therefore, breakdown torque must be higher-a minimum of 140 per cent of the breakdown torque of a sing >-phase general-purpose motor-so that full-load speeds are comparable. Starting torques of polyphase motors may vary between 200 and 350 per cent of full-load torque, Fig. 3c.

Polyphase multiple-speed motors may have multiple windings, single windings (consequent pole), or both. Multiple-windings are separate windings, one for each speed. Three-phase multiple-speed motors have three leads brought out for each speed. Two-speed motors are common, but three-speed motors are rare.

Two-phase motors are seldom encountered, and multiple-speed two-phase motors are practically non-existent.

Single-winding consequent-pole designs use a special connection to provide two-speed performance. This type always has a 2:1 speed ratio; for example, 1800/900, 3600/1800. Consequent-pole windings may be combined with multiple windings to provide three or more speeds.

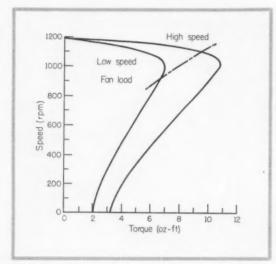


Fig. 6—Speed-torque curves for a two-speed, six-pole, permanent-split capacitor motor.

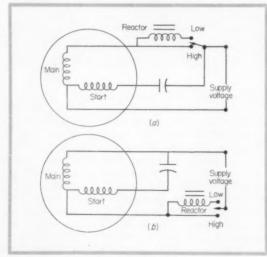


Fig. 7—Possible winding connections for obtaining two speeds from a permanent-split capacitor motor. Reactor is in series with, a, main winding only, and b, both main and start windings.

Because of the simpler connections, motors with separate windings require a less costly control system than consequent-pole motors. However, the motor-control combination may be more expensive than the consequent-pole design.

Polyphase-fractional horsepower motors are usually variable-torque designs, but constant-torque and constant-horsepower motors are available as specialty items.

Single-Phase Motors: The types most common are split phase, multiple speed, capacitor start, permanent-split capacitor, and shaded pole. Other types are available but their uses are more specific. Each type of motor has characteristics which are best suited to certain jobs.

Split Phase: A split-phase motor has two windings—a main winding and an auxiliary or start winding. Because voltage change has little effect on speed, these motors have essentially constant speed.

The auxiliary winding induces a torque that causes initial rotation and acceleration. When a predetermined speed (the cutout point) is attained, a centrifugal mechanism opens a set of switch contacts in the start-winding circuit. Then, the motor accelerates with only the main winding energized. The centrifugal mechanism is usually a spring-loaded device located on the rotor shaft. The contacts, depending on rotor speed, either energize or prevent energizing of the auxiliary winding.

Starting torque of split-phase motors depends upon the power specified. Starting torques are generally in the range of 125 to 200 per cent of full load, Fig. 3a, except for shaft-mounted fan designs where the values may be lower. As a result, split-phase motors are considered as low, or moderate, starting-torque

Multiple Speed: While not necessarily a distinct motor type, single-phase two-speed motors (pole-changing motors) are frequently included in motor manufacturers' handbooks. Most common are the variable-torque designs which are used primarily in the fan and blower industry.

These motors are single-voltage types only because dual-voltage, dual-speed motors require a cumbersome number of leads. The speed control is usually a single-pole double-throw switch, or if both sides of the line must be opened, a double-pole double-throw switch. Most of these controls have three positions: "Hi—Off—Lo."

The most common speeds are 1725/1140 rpm (4/6 pole) and 1140/850 rpm (6/8 pole). Other speed combinations, as well as constant-torque and constant-horsepower motor designs, are seldom if ever used.

For split-phase and capacitor-start motors, each speed requires a separate winding. Running performance is similar to the single-speed counterparts. Power on the lower speed is approximately 33 per cent of the high-speed value on 4/6 pole variable-torque motors and 40 per cent on 6/8 pole variable-torque designs. (Because different techniques for obtaining multiple speeds are used with permanent-split capacitor and shaded-pole motors, the methods

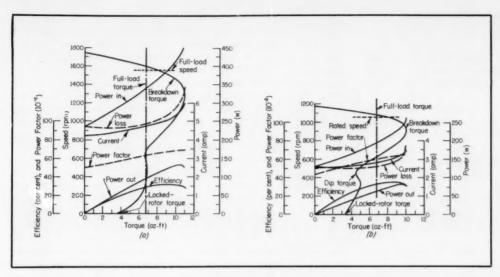


Fig. 8—Typical performance curves for shaded-pole, fractional-horsepower motors. Data for a: 4 poles, $\frac{1}{8}$ hp, 115 v, 60 cps. Data for b: 6 poles, $\frac{1}{12}$ hp, 115 v, 60 cps.

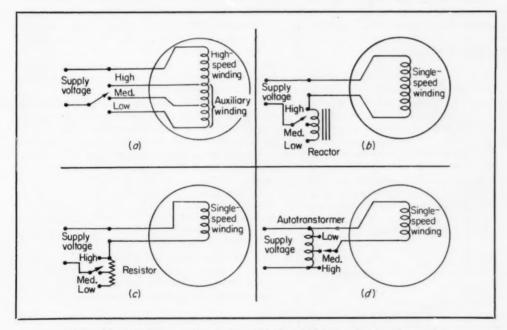


Fig. 9—Schematic diagrams of typical methods for obtaining multiple-speed operation from shaded-pole motors: a, additional stator turns in series with high-speed winding; b, tapped reactor in series with motor winding; c, tapped resistor in series with motor winding; d, tapped autotransformer across supply voltage.

are discussed in following sections.)

Capacitor Start: In many respects, the capacitorstart, induction-run motor is similar to the split-phase motor. The main difference is the use of a capactor in series with the auxiliary winding. The capacitor-start motor produces appreciably more locked-rotor and accelerating torque per ampere than does a split-phase motor.

After the start winding is removed from the circuit, Fig. 3b, performance of a capacitor-start motor is nearly identical to that of a split-phase motor.

Consequently, capacitor-start motors should be used where the load-acceleration and locked-rotor torques exceed the capacity of a split-phase motor. The locked-rotor torque of a general-purpose capacitor-start motor is approximately 400 per cent of its full-load torque.

Permanent-Split Capacitor: Like the capacitorstart motor, the permanent-split capacitor motor has an auxiliary winding with a capacitor. However, the capacitor and auxiliary windings in a permanentsplit design are continuously energized and aid in producing a higher power factor than do other designs. Efficiency is comparable to, and sometimes better than, the efficiency of other single-phase motor designs.

Locked-rotor torque is low compared to that of either split-phase or capacitor-start motors. Therefore, permanent-split capacitor motors are generally applicable only to direct-drive fan and blower applications—they are not recommended for belt-driven loads. In special cases, permanent-split designs with higher locked-rotor torque are designed for intermittent ratings, but this is rare.

Because the auxiliary winding is designed for continuous service, this type of motor does not have a centrifugal switching mechanism. Usually, this arrangement permits a shorter motor than other single-phase motors.

Since the auxiliary winding is never removed from the circuit, this design conveniently lends itself to speed control. Speed is adjusted by changing either motor voltage or main-winding voltage, usually by introducing a series reactance. A reactive device for obtaining specific or continuously variable speeds is simply an iron-core coil with a number of taps. In effect, it supplies reduced voltages to the motor.

Performance curves of typical permanent-split capacitor motors are shown in Fig. 5. The performance curve of a two-speed motor is shown in Fig. 6. This type of operation can be obtained either with auxiliary main windings or by connecting resistors or reactors in series with the main winding, Fig. 7. Best speed stability is produced by connecting the resistor or reactor in series with the main winding only, Fig. 7a. This connection also maintains adequate voltage across the start winding to assure sufficient starting torque when running at low speed. An autotransformer can be used in place of resistors or reactors for adjustable speed control.

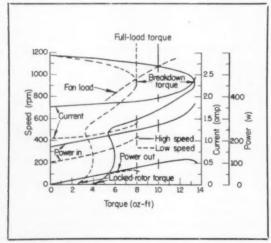


Fig. 10—Performance curves for a two-speed, six-pole, shaded-pole motor rated at 1/10 hp, 230 v, 60 cps.

Power ratings for permanent-split capacitor motors in Table 4 are different from those in Table 3 for general-purpose motors. Also, normal operating, as well as nameplate, speeds are different.

Generally, a permanent-split capacitor motor is customer designed for a specific application. Open-construction motors are usually rated for a 50 C rise. Where the motors are used as fan drives, air passing over the motor is used as a cooling medium. In these cases the motors are rated "continuous, air-over." Tests are recommended in all proposed applications of these motors.

Where space is a premium, the capacitor may be mounted in a remote location. When capacitors are located on the motor, they are either strap mounted or mounted within a complete cover. A mounting strap is a simple metal band which is usually secured to the motor shell. In addition, an insulator or boot protects and conceals the live conductors where they are joined to the capacitor terminals. This method is less costly than mounting within a cover and is often used where appearance is not important. While many capacitors are so large they cannot be conveniently covered, some capacitor designs are now so small they can be located inside the motor.

Shaded Pole: In general, both torque characteristics and uses of shaded-pole motors are similar to those of permanent-split capacitor motors. The main differences are lower efficiency and power factor, which cannot equal the values produced by a distributed-winding design.

In place of an auxiliary winding, shaded-pole motors have a solid, continuous copper loop around a small portion of each salient pole. This shorted loop, or shading coil, causes the reaction necessary to give the motor its starting torque. The coil produces moderate torque during acceleration and running.

Because of its simple mechanical construction, the shaded-pole motor is usually the lowest priced induction motor. However, its low efficiency, power factor, and starting torque make it suitable in most cases only for direct-drive fan and blower applications. The motor must nearly always be located in an air stream. Enclosed versions are possible only in the smaller ratings (1/8 hp and lower), or where the cooling effect of the air stream is exceptionally good.

Shaded-pole motors with four and six poles (1550 and 1050 rpm) are most common. Power ratings, Table 4, as with permanent-split capacitor motors, are different from those of general-purpose motors. Performance curves, Fig. 8, show that watts loss (watts input minus watts output) is nearly constant between no load (zero torque) and full load (rated torque). Therefore, light loading does not reduce losses appreciably.

Multiple-speed techniques for permanent-split capacitor motors also apply to shaded-pole motors, Fig. 9. A typical performance curve for a multiple-speed shaded-pole motor is shown in Fig. 10.

Next article, which concludes this two-part series, covers mechanical features and standards of fractional-horsepower motors.

Simplified procedure avoids trial-and-error calculations in predicting . . .

Hydraulic-System Temperatures

CHARLES D. WOOD

Test Engineer **Engineering Laboratories** Temco Electronic & Missiles Co. Dallas, Texas

NALCULATION of the maximum expected temperature in a hydraulic system normally requires selection of heat-transfer coefficients, calculation of system parameters, writing of the heat-balance equation, and finally, the solution of

the equation. This article presents a simplified of a chart.

Nomenclature

- A = Outside area of system, sq ft
- A_8 = Surface area of surroundings, sq ft
- D' = Average diameter of tubing, reservoir, and components in system, ft
- Fa = Gray-body shape factor
- $F_T = \text{Temperature factor} = 0.171 [(0.01 T_{M'})^4 (0.01 T_8)^4$]/ $T_{M'}$ - T_8 Btu/hr-sq ft-deg F
- he = Convection heat-transfer coefficient, Btu/hr-sq ft-deg F
- h, = Radiation heat-transfer coefficient, Btu/hr-sq ftdeg F
- K₁ = Conversion constant = 1.481 Btu-min/hr-psi-gal
- $K_2 = \text{Conversion constant} = 0.001285 \text{ Btu/ft-lb}$
- P = Generated heat, Btu per hr
- $\Delta p = \text{System pressure drop, psi}$
- Q = System flow rate, gpm
- $q_c =$ Heat loss from convection, Btu per hr
- q_r = Heat loss from radiation, Btu per hr
- TM' = Average maximum system temperature, deg Rankine
- $T_S =$ Temperature of surroundings, deg Rankine
- V = System volume, cu ft
- dW/dt =Rate of work done by system, ft-lb per hr
 - ε = Emissivity of surface of system
 - es = Emissivity of surroundings
 - $\eta = Pump$ efficiency, per cent

method for predicting maximum system temperature. This method, valid for all systems, requires only the computation of system parameters and the use

Basic Relationships: In a hydraulic system, heat is generated by the dissipation of pressure energy which produces no work. Examples are the flow of fluid through a relief valve, the leakage flow through a servo valve, and the frictional pressure drop in lines and through components.

Rate of heat generation may be calculated from the relationship: Heat generated equals work input minus work output.

$$P = \frac{K_1 \Delta p Q}{\eta} - K_2 \frac{dW}{dt} \tag{1}$$

If the work done is of a cyclic nature, then dW/dtmust be an average rate over one complete cycle. When the system temperature is at its maximum value, the heat generated equals the heat dissipated. Thus.

$$P = (h_c + h_\tau) A (T_{\underline{M}}' - T_{\underline{B}}) \tag{2}$$

where

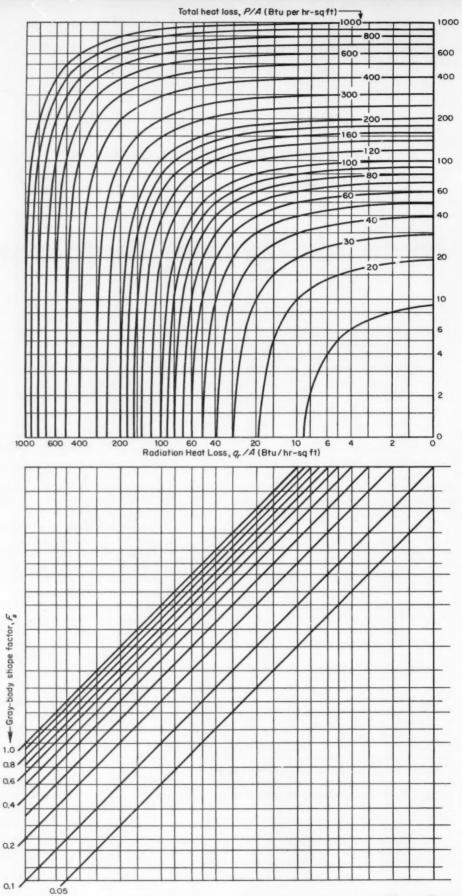
$$h_c = 0.22 \left(\frac{T_{M'} - T_{S}}{D'} \right)^{0.25}$$

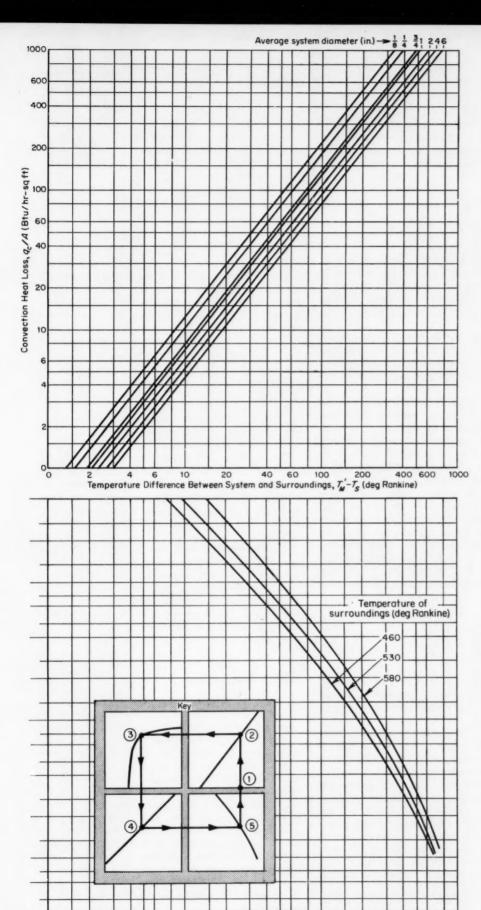
and

$$h_r = F_R F_T$$

The relationship for convection heat-transfer coeffi-

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HYDRAULIC-SYSTEM TEMPERATURES

Fig. 1—Graph for determining hydraulicsystem temperatures.

TEMPERATURES

cient h_e , which has been determined from experimental data, is valid for free convection from horizontal pipes and cylinders.* Substitution and rearrangement of Equation 2 yield

$$\frac{P}{A} = \frac{0.22}{(D')^{0.25}} (T_{M'} - T_{B})^{1.25} + 0.171 F_{B}[(0.01 T_{M'})^{4} - (0.01 T_{B})^{4}]$$
(3)

In an actual system, fluid temperature varies with location. The temperature at a given location is a function of the nearness to heat-producing components. However, the entire system is assumed to be at an average, or "mixing-cup" temperature T_{M} .

Average diameter D' may be closely approximated by 4V/A. Thus, shapes that cannot be described by a diameter (box-shaped reservoirs, irregularly shaped components) are assigned an equivalent diameter and averaged.

Gray-body shape factor F_B is the product of the geometric-shape factor and an emissivity factor that allows for the departure of the surfaces of the system from black-body conditions. Generally, the system may be assumed to be a small body in black (perfectly absorbing) surroundings. This assumption is valid for a system installed in a large room or out-of-doors. Here, F_8 is approximately equal to ε , the emissivity of the surfaces of the system. The emissivity for various materials ranges from values approaching zero to values approaching one. The emissivities of various materials are listed in engineering handbooks. When the system is surrounded by a gray enclosure with an area that is not large compared to the area of the system, F_8 may be closely approximated by

$$F_S = rac{1}{rac{1}{arepsilon} + rac{A}{arepsilon_S A_S} - rac{A}{A_S}}$$

Solution of Equation 3 for T_M involves a trial and error procedure. Fig. 1 provides a simple graphical substitute for these calculations.

Example: A hydraulic system operates a cylinder to exert a constant force of 80.3 lb through a distance of 0.8 ft in a cyclic manner. The force is exerted for 1½ sec. The piston is retracted during the next second, and negligible work is done during the retraction. Thus, the complete cycle has a duration of 2½ sec. The volume of the system is 7 gal. Outside area of the system is 11.2 sq ft. Pump output is 2 gpm at 90 per cent efficiency. Pressure increase across the pump is 630 psi. The system is located in a large room. Emissivity of the material used in the system is 0.5. Ambient temperature is 70 F.

Solution: First, calculate the system parameters. Work rate dW/dt=80.3~(0.8)(3600)/2.5=92,500 ft-lb per hr. Average diameter D'=4V/A=4(7)(0.1337)/11.2=0.334 ft or approximately 4 in. From Equation 1,

$$P = \frac{(1.481)(630)(2)}{0.90} - [92,500(0.001285)]$$
= 1961 Btu per hr

Then, P/A = 1961/11.2 = 175.2 Btu per hrsq ft.

Enter the chart, Fig. 1, in the first quadrant with an assumed value of $T_{M'}-T_{S}$. Draw a vertical line to the line corresponding to D'=4 in. Draw a horizontal line from this intersection to the curve corresponding to P/A=175. Continue the line downward to $F_{S}=0.5$, and then horizontally to $T_{S}=530$. From this intersection, draw a vertical line to find a new value of $T_{M'}-T_{S}$. If the assumed and the new values of $T_{M'}-T_{S}$ are not equal, another value of $T_{M'}-T_{S}$ is chosen and the process is repeated. No more than three trials are usually required to arrive at the correct value of $T_{M'}-T_{S}$. The solution, Fig. 1, shows that $T_{M'}-T_{S}$ is 108 F and that $T_{M'}$ is 178 F. If temperature $T_{M'}$ is higher than desired, the

If temperature T_{M} is higher than desired, the chart may be used to evaluate the available ways of reducing temperature. The effects of increasing outside area, decreasing generated heat, increasing emissivity (perhaps by painting the surfaces black), or changing the ambient temperature can be determined.

In addition, the chart can be used to find the heat loss by convection and by radiation. From the ordinate in the second quadrant, heat loss by convection is 100 Btu per hr-sq ft in the example. From the abscissa of the second quadrant, heat loss by radiation is 75 Btu per hr-sq ft. The sum of these two heat losses must equal P/A.

They Say . . .

The character of the [engineering] profession itself is undergoing significant change. The engineer has been viewed historically as the intermediary who converts scientific discoveries to practical, workable form. This conception of the profession is inadequate today. The present-day engineer is frequently at the forefront of scientific advance, and there is a growing fusion of interest and activity of the engineer and scientist. The instruments upon which scientists must depend for their data, unique materials they must have for their experiments, and novel processes necessary to their studies are some of the contributions of engineers. Conversely, engineering considerations are generating demands for new scientific concepts, theories, and data.—EDWARD E. Slowter, Vice President, Battelle Memorial Institute.

^{*}M. Jacobs and G. A. Hawkins—Elements of Heat Transfer and Insulation, John Wiley and Sons Inc., New York, Second Edition, 1954, p. 107.

D-131 D-132 D-133 D-136 D-136 D-137 D-138

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design engineering SHOW

The Design Engineering Show and Conference . . .

At Cobo Hall, Detroit, May 22-25, 1961

Conference Hours:

May 22-10:00 a.m. to noon

May 23, 24, 25-9:30 a.m. to noon

Show Hours:

May 22, 24, 25-noon to 5:30 p.m.

May 23-noon to 10:00 p.m.

Fee for the Conference: \$10 for ASME members, \$15 for nonmembers-also includes admittance to the Show Fee for the Show: \$2, payable at the Registration Desk

On the following pages, new products to be shown and exhibitors are divided into product areas as follows:

	Page
Electric, Electronic	212
Fluid Power	216
Materials, Processes and Parts	222
Mechanical Equipment	226
Assembly Components	230
Engineering Department Equipment	234
Also in this Show Guide:	
Conference Program	236
Alphabetical Exhibitor List	239
Floor Plan of Cobo Hall	240

. . . Short Course in Know-how

A design engineer, unlike the proverbial jack-of-all-trades, has to be master of quite a few things: He must be aware of and know how to employ all kinds of materials, finishes, components, assemblies, and systems. One way to maintain an up-to-date mastery of this phase of design know-how is to attend the annual Design Engineering Show, where some 400 manufacturers will display and discuss products and applications.

This Show Guide (which serves as either a preview or a stay-at-home substitute) lists products that will be exhibited. They are separated into six basic areas: Electric and electronic; fluid power; materials, processes, and parts; mechanical equipment; assembly components; and engineering department equipment. Further information can be obtained with the special De-

sign Show inquiry card.

Circle 10-8 on Page 19 for extra copy.

Electric, Electronic

Fluid Power Materials, Processes, and Parts **Mechanical Equipment Assembly Components Engineering Department** Equipment



112 Remote, adjustable Stedi-Temp controls temperature of liquids, solids, or gases in two standard ranges: 0 to 450 F or 450 to 800 F. Accuracy is usually within ±2 F. Electro-Flex

Circle D-1 on White Card

in the booths . . .

- 112 Electro-Flex Heat Inc. -Flexible heating elements, temperature controllers, crystal ovens
- 121 Cleveland Graphite Bronze Div., Clevite Corp. - Piezoelectric spark pumps
- 124 Burling Instrument Temperature controls, temperature alarms, thermostats
- 162 M. H. Rhodes Inc .--Timing devices, time-delay relays, coin meters and associated components
- 201 Adams & Westlake Co.—Mercury plunger type load and time-delay relays and mercury-wetted contact relays
- 211 Sigma Instruments Inc.-Impulse relays, overload interrupters, heavy-duty ac-dc re-lays; other controls and motors
- 220 Edwin L. Wiegand Co.—Appliance electric-range heating elements, electric im-mersion heaters, infrared and other types of heaters
- 223 Acro Div., Robert-show-Fulton Controls Co.—Switches, relays, and motors

- 228 Thomas & Betts Co. -Electrical fittings, terminals. connectors
- 232 Enfab Inc.-Insulation
- American Standard Controls Div.—Miniature switches and appliance type solenoids
- 300 Miller Electric Co.— Retractile coiled cords; insulated eleccoiled tric wire; molded-on plugs, connectors and components; electric cord sets
- Cleveland Machine Inc.—Adjustable-speed drives
- 356 Robbins & Myers Inc. -Fractional and integral-hp motors
- 422 Circle F Mfg. Co .-Toggle, push-type, and slide switches; other wiring devices
- General Electric Co. (General Purpose Motor Dept., Specialty Motor Dept., and General Purpose Control Dept.) — Fractional-horsepower motors, small ac and de motors, motor starters, limit switches, solenoids, pushbut-tons, relays, terminal boards, and pilot control devices

- 442 Durakool Inc.-Highpressure, arc-quench-ed mercury contactmercury relays, and all-steel mercury tilt switches
- Amco Engineering Co.—Electronic instrumentation enclosure system
- Fenwal Inc.—Transistorized temperature controllers; other con-trollers for local and remote devices
- U. S. Electrical Motors Inc.—Motors and adjustable - speed drives
- Sylvania Electric Products Co., Special Products Div.—Circuit breakers, transformers, and Panelescent lamps
- Eaton Manufacturing Company, Dynamatic Div. — Watercooled, eddy-current adjust-able-speed drives
- 720 Elastic Elastic Stop Nut Corp. of America, Elizabeth Div.—Timedelay relays
- 720 Buchanan Electrical Products Corp.—Pre-insulated splice caps
- 844 Licon Div., Illinois Tool Works Pushbutton switches

508 Speed ratios up to 10:1, from 4 to 10,000 rpm, are provided by fractional (1/4 hp) to 1 hp 1/4 Varidrive. Easy-operating hand trol assures accurate settings. Electrical Motors Inc.

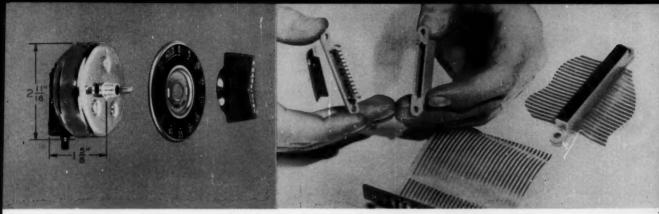
Circle D-4 on White Card



720 Steel splice cap with nylon in-sulator accommodates two No. 18 wires through four No. 12 wires. To whe through four No. 12 wires.

Crimp made during installation strengthens the cap. Buchanan Electrical Products Corp.

Circle D-8 on White Card



162 Function as a snap switch or a timer is an optional feature of 15-amp, 125-v ac bell-signal time switch. The bell is also optional. Timing ranges are from 60 sec to 12 hr. M. H. Rhodes Inc.

Circle D-2 on White Card

228 Printed-circuit board connections with flat conduc-A continuous spring that locks the cable into the ctor also provides pressure at each contact. Thomas connector also provides pressure at each contact. & Betts Co.

Circle D-3 on White Card

336 Electronic adjustable-speed drives are rated at 3 hp maximum (size 3) and 7½ hp maximum (size 4). Maximum speed range is 100:1. Cleveland Machine Controls Inc.

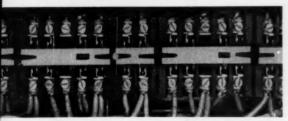
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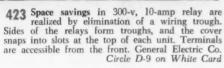
720 Miniaturized, solid-state time de-lay relays operate either on pull-in or drop-out, in a total span from 0.01 sec to 10 hr. Adjustment ratios, in one relay, range from 10:1 to 3000:1. Relays are for -55 to 70 C or 55 to 125-C use. Elizabeth Div., Elastic Stop Nut Corp. of America. Circle D-6 on White Card

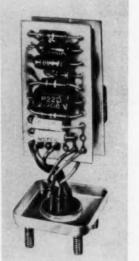
460 A transistorized control circuit and an independent indication circuit are featured in model 561 temperature indicating controller, which is accurate to within 0.1 F. Its range is -50 to 600 F. Fenwal Inc.

Circle D-7 on White Card



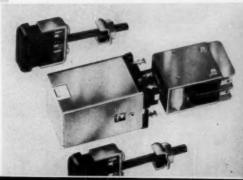






844 Four colors can be displayed on the indicator screen of the Series 04 lighted pushbutton switch. Pushing the 7/8-in. square screen actuates two subminiature switches capable of controlling two 5-amp or one 10-amp, 30-v de circuit or two 10-amp, 125-250 v ac circuits. Licon Div., Illinois Tool Works

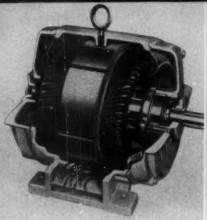
Circle D-10 on White Card





853 Modular construction is a feature of external-clutch reset Acrotimer, which provides delay or interval timing. Adjustable time ranges are 6, 15, 30, 60, and 120 sec; 5, 10, and 30 min; and 1, 2, and 4 hr. Timer is available with one 15-amp load switch or two 10-amp switches. Haydon Div., General Time Corp.

Circle D-11 on White Card



945 Encapsulated, random-wound ac induction motors protect against moisture, chemicals, oils, and abrasive contaminants, providing long life. Motors are available in open, drip-proof ratings, 445U frame size and smaller. Louis Allis Co.

Circle D-12 on White Card



1119 Rated at 20 amp per pole at 115 v ac, miniature power relay is available with normally open and/or normally closed contacts. It features hermetically sealed, silent mercury-to-mercury contacts within an inert, arc-quenching atmosphere, and visual observation of its one moving part. Ebert Electronics Corp.

Circle D-13 on White Card

Electric, Electronic (cont.)

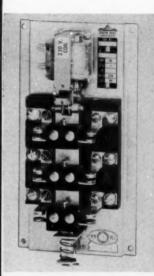
in the booths . . .

- 853 Haydon Div., General Time Corp.—Reset timers, the electric brakes and clutches, elapsed time indicators, timing motors and controls
- 921 Century Electric Co.

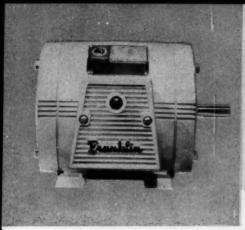
 Adjustable speed drives, electric mo-
- 924 Tann Corp.—Proximity limit switches
- 945 Louis Allis Co.— Electric motors and adjustable - speed drives
- 1014 Eagle Signal Corp.
 —Timing devices
- 1023 ACF Electronics Div., ACF Industries Inc. —Fractional and integral-horsepower adjustable-speed motor controls
- 1052 Franklin Electric Co. Inc.—Fractional and integral - horsepower motors
- 1055 Columbus Electric
 Mfg. Co. Switches,
 temperature controls

- 1061 Stahlin Brothers Inc.
 —Wiring raceways
 and connections
- 1063 Mycalex Corp. of America — Commutation plates and telemetering switches
- 1116 Deluxe Coils Inc.— Electrical coils and windings
- 1118 Cherry Electrical
 Products Corp.—
 Hinged and rollerlever actuated switches, miniature switches
- 1119 Ebert Electronics
 Corp. Mercury
 relays, electronic sensitive relays, photoelectric controls
- 1121 Brook Motor Corp.— Integral - horsepower motors
- 1145 Linemaster Switch Corp.—Foot switches
- 1148 Electro Mechanical Instrument Co.—Voltmeters, ammeters, milliammeters, microammeters, and edgereading indicators
- 1157 ETC Inc.—Solderless electrical terminals and connectors

- 1160 Landis & Gyr Inc.— Electrical impulsecounters and impulsetransmitting devices
- 1162 Potter & Brumfield
 Div., American Machine & Foundry Co.
 —Relays, including
 power, general-purpose, high-performance, special-purpose,
 and telephone types
- 1211 Micro Switch Div., Minneapolis - Honeywell Regulator Co.— Precision snap-action switches
- 1217 Panduit Corp.—Plastic wiring duct; cable clamps, ties, sheath
- 1237 Zenith Electric Co.—
 Automatic transfer switches, magnetic contactors, special control relays, timing controls, and programming devices
- 1240 Ucinite Co. Div., United-Carr Fastener Corp. — Electromechanical components
- 1247 Heinemann Electric
 Co.—Circuit breakers,
 time-delay relays,
 and overload relays



1237 Available in 25 or 50-volt sizes with up to 20 poles, Model SC-33 solenoid contactor is designed for limited-space applications. It can be adapted for control of lighting circuits or for timing applications for control of three-phase motors through 3 hp. Zenith Electric Co. Circle D-19 on White Card

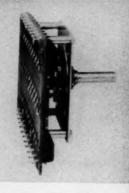


1052 Lightweight, aluminum integral-horse power motors incorporate prepacked, double-shielded bearings, and quick-connect terminal board that permits prewiring to requirements. Single and polyphase motors are available, with I to 7½ hp. Space is provided for inherent overload protection devices. Franklin Electric Co. Inc.

Circle D-14 on White Card

1162 Maximum height of 0.485 in. is a feature of Type FL latching relay. It is a dual-coil, latching relay. It is a dual-coil, microminiature unit which has its smallest dimension perpendicular to the plane of its mounting surface. Relay withstands 100 g shock, 400 g linear acceleration, and vibration of 0.195 in. excursion from 10 to 55 cps and 30 g from 55 to 2500 cps. Potter & Brumfield Div., American Machine & Foundry Co. & Foundry Co.

Circle D-17 on White Card



1240 Over 1000 switch combinations are provided in two Uniplane monoplanar basic switch kits. Model 610 provides 528 different nonshorting selector-switch arrangement from itself. rangements, from single-pole, two-position to 8-pole, 12-position, in any one of three drive-shaft orientations. Model 611 provides the same number of combinations in charter stulnations in shorting-style se-lector switches. Ucinite Co., United-Carr Fastener Corp. Circle D-15 on White Card

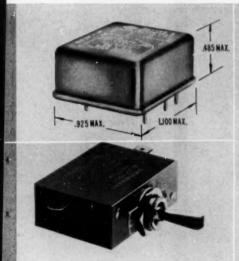


1157 Large wire sizes through No. 2 AWG are covered by a line of solderless electrical terminals and connectors. Included are elongated and standard ring terminals, and butt and parallel connectors. Terminals and connectors are arc annealed, pure copper electroplated with tin. They are for stud sizes No. 6 through 3/4 in. ETC Inc.

Circle D-16 on White Card

1118 Simplified coil-spring construction provides long mechanical and electrical life with 0.050 in. minimum overtravel in E33-00A snap-action switch. Flat case, 1 3/32 x 3/32 in., permits individual or gangassembly use for multiple cam operation. Rating is 10 amp, ½ hp, 125/250 v ac. Cherry Electrical Products Corp.

Circle D-18 on White Card



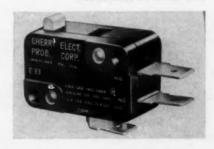
1247 Weighing 11/2 oz, Series VP 1247 Weighing 1½ oz, series VP hydraulic-magnetic circuit breaker is usable in airborne, portable, and mobile equipment. A single-pole unit, it operates at 110 V, 60 or 400 cycle ac, or at 500 V dc, in any current rating from 0.05 through 15 amp. Heinemann Electric Co mann Electric Co.

Circle D-20 on White Card



Bounce-free voltage output from a mechanical switch is produced by 1PB 2000 electronic switch. Four packages are available: One produces a positive out-put to accommodate resistive loads of 100 to 500 ohms; another produces a positive output for resistive loads of 500 ohms or greater; and two produce a negative output voltage for these loads. Micro Switch Div., Minneapolis-Honeywell Regulator Co.

Circle D-21 on White Card



1217 Rounded top surfaces on Type E Panduct open-slot plastic wiring duct protect wire insulation and prevent irritation of the installer's hands. Duct is easily cut, and corners can be mitered at any angle. Standard 5 or 6-ft lengths are available in white, black, dark gray, or light gray. Panduit Corp. Circle D-22 on White Card

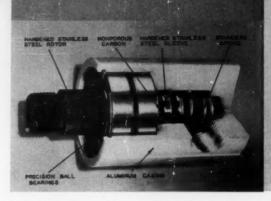


Electric, Electronic

Fluid Power

Materials, Processes, and Parts Mechanical Equipment Assembly Components

Engineering Department Equipment



Minimum of turning torque at speeds around 1500 rpm results in long life for ½-in. BB type revolving joint. It is rated at 500 lb air or hydraulic pressure, and construction is predominantly stainless steel and aluminum. Rotherm Engineering Co. Inc.

Circle D-23 on White Card

in the booths . . .

- 101 Janette Div., National Pneumatic Co. Inc. —Cylinders and valves
- 104 Rotherm Engineering
 Co. Inc.—Revolving
 joints, expension
 joints, cir nozzles, and
 humidifiers
- 105 Greene, Tweed & Co.
 —Rod seals, packings, and hard adapters for V-packing
- 106 Stratoflex Inc.—Hose fittings and assemblies
- 107 Wilkerson Corp.— Filters and lubricators with unbreakable bowls
- 119 Roper Hydraulies Inc.

 —Rotary gear pumps
- 123 Kobe Inc.—High-pressure pumps for extreme temperatures
- 127 Vanton Pump δ
 Equipment Corp.,
 Div. of Cooper Alloy Corp.—Pumps,
 valves, and fittings
- 129 Leiman Bros. Inc.—
 Rotary vacuum
 pumps and rotary
 pressure pumps
- 154 Chicago-Allis Mfg.
 Corp. Mechanical
 face and lip seals
 and packings

- 160 Air-Maze Div., Rockwell-Standard Corp. —Engine air intake filters, oil filters, breather filters, and exhaust spark arresters
- 209 Nuclear Products Co.

 —Metering valves,
 poppet check valves,
 plastic valves, tube
 plugs, and purge
 valves
- 214 Commercial Filters Corp.—Filters for industrial fluids
- 222 DSD Mfg. Co.—Orings, quick-disconnect clamps, gaskets, and seals
- 223 Fulton Sylphon Div., Robertshaw - Fulton Controls Co.—Metal bellows and assemblies
- 223 Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co.— Bellows and assemblies, pump switches, air volume controls, and pressure-relief valves
- 224 Fawick Airflex Div., Fawick Corp.—Seals
- 237 Crane Packing Co.—
 Mechanical axial
 seals, lip seals, hydraulic valves, and
 pump packings

- 257 American Standard Controls Div.—Lowpressure solenoid valves
- 311 Flodar Corp.—Tube fittings
- 312 Anaconda Metal Hose Div., Anaconda American Brass Co.—Flexible metal and plastic hose and tubing
- 327 Waldron Couplings, Waldron-Hartig Div. —Standard and highspeed couplings
- 357 Pennsylvania Fluorocarbon Co. Inc.— Teflon-lined rubber tubing, expanded Teflon tubing, and spaghetti and flexible Teflon tubing
- 400 United Shoe Machinery Corp.—Hermetically sealed
- 455 Hoke Inc.—Valves, pressure regulators, flow gages, other fluid controls
- 501 Wooster Div., Borg-Warner Corp.—Hydraulic gear pumps, directional - control valves, motors, relief valves, and flow-control valves

214 Corrosive and hightemperature fluids are filtered by stainlesssteel filter element for Fulflo filter. Elements are available in 40, 20, 5, and 2-micron particle retention ratings; sizes are 10, 20, and 30 in. long by 23/4 in. OD. Commercial Filters Corp. Circle D-27 on White Card

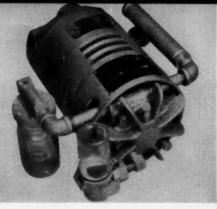
311 Fittings are assembled as a manifold in the Maniport system. Any number of combinations are possible, and the assembly can be changed as required. Fittings are fluid-run type, and their sides have take-off line connections for base and tubing. Flodar Corp.

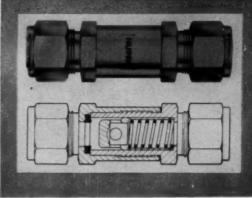
Circle D-28 on White Card

455 Miniature low-pressure switch has maximum set pressure of 7 psi. Dead-band is 2 in. of water, and repeatable accuracy is ±0.5 per cent. Hoke Inc.

Circle D-29 on White Card





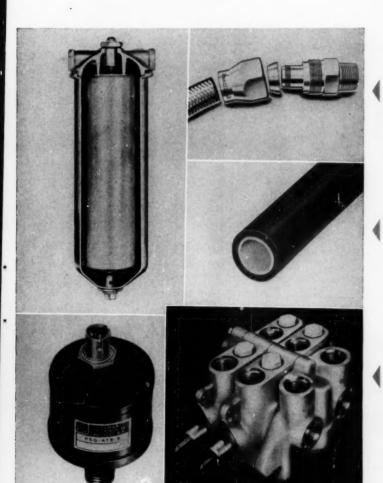


107 Zinc-alloy reservoir for compressed-air filters and lubricators resists high temperalubricators resists high tempera-tures, high pressures, impact, steam, and solvents. The Saf-T-Bowl has a protected Pyrex sight-level indicator, visible over a 230-deg arc. Wilkerson Corp. Circle D-24 on White Card

129 Vacuums to 27 in. Hg, or pressures to 15 psi are produced by model K-5 integral pump and motor. Displacement is 12 cfm. The pump measures 22½ by 12 by 9½ in. Leiman Bros. Inc.
Circle D-25 on White Card

209 Unidirectional flow is provided by a poppet check valve designed for instrument, process, and control lines. Large flow areas minimize pressure drop. The valve is for use with 3/8, 1/2, and 5/8 in. tubing. Nuclear Products Co.

Circle D-26 on White Card



312 Flexible core of Teflon is reinforced with stainless-steel wire braid in T4 hose. End fittings are detachable and reusable, and the hose can be used at temperatures from -65 to 450 F. Anaconda Metal Hose Div., Anaconda American Brass Co.

Circle D-30 on White Card

357 Lined tubing combines physical and chemical properties of Teflon with the protection and thermal insulalation of rubber. The tubing is available with ½ through 1 in. ID Teflon liner, covered with ½ in. neoprene rubber or other elastomer. Pennsylvania Fluorocarbon Co. Inc.

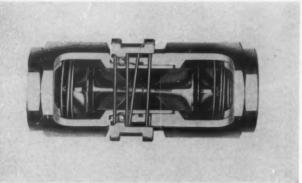
Circle D-31 on White Card

Circle D-31 on White Card

501 Operating at pressure up to 2000 psi, stack-type directional control valve lifts, tilts, and positions. It is built for heavy-duty service. Wooster Div., Borg-Warner Corp.

Circle D-32 on White Card

Fluid Power (cont.)



512 Large-capacity, shut-off coupling is a two-way type.
When coupling is disconnected, identical guided valves in socket and plug instantly contact valve seats to seal flow of gas or liquids from both sides of line.
Hansen Mfg. Co.

Circle D-33 on White Card



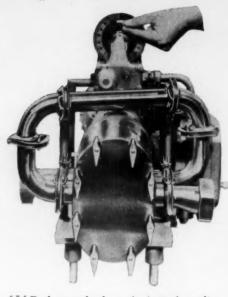
549 Need for replacement of cartridge is indicated by a mechanical pointer (or electrically by a signal light or bell) in Tell-Tale hydraulic filter. For use on suction lines, the filter is rated for flows from 2 to 250 gpm. Vickers Inc., Div. of Sperry Rand Corp.

Circle D-34 on White Card



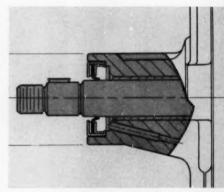
619 Large-diameter, high-pressure hose is for 1½ to 2-in. systems operating at pressures to 3000 psi. 2755 Spiral Wrap hose is constructed of alternating layers of spiral wire wrapping and synthetic rubber. Aeroquip Corp.

Circle D-35 on White Card



616 Dual pump head permits internal equalization of pressures, eliminating slippage—and providing 99.5 to 99.7 volumetric efficiency—in metered flow control pump. Stainless-steel MFC-250 positive-displacement pump measures and transfers fluids of widely varying viscosities and densities. Pump Div., Waukesha Foundry Co.

Circle D-36 on White Card

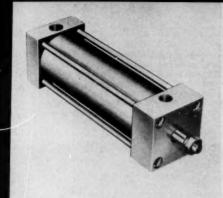


618 Sealing at speeds to 3000 fpm, Positive-Seal Klozure oil seal has long-life Teflon lining. Construction features include a steel shell which encloses and positions all components and a tightly fitted gasket which holds the sealing element in place. Garlock Inc.

Circle D-37 on White Card

910 Shatterproof, transparent Safety Green bowls are designed for air-line filters and lubricators. Capacities range from ½ oz to ½ pt. C. A. Norgren Co.

Circle D-38 on White Card



544 General-purpose air-power cylinders, rated 200 psi maximum, are available in 11/4 to 41/2 in. bore sizes with standard strokes to 20 in. Floating cushions to reduce impact of stroke can be added without increasing overall length. Hannifin Co., Div. of Parker-Hannifin Corp.

Circle D-39 on White Card

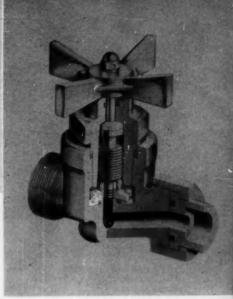
900 One-inch diameter, 5 oz solenoid valve is designed for use in hydraulic and pneumatic devices and control sys-tems. Operating differential pressures range from 5 microns to 150 psi. Skinner Electric Valve Div., Skinner Precision Industries

Inc.
Circle D-42 on White Card



825 Low-pressure solenoid valve has 3/4 in. pipe connections. Body and bonnet are forged brass, and the valve has a soft composition disc. It is constructed to FM and UL requirements. Automatic Switch Co.

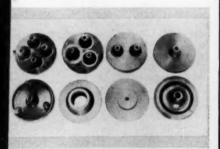
Circle D-40 on White Card



805 High-pressure valves and fittings in the O-Seal series include hand-operated, 6000-psi valves; hand-tightened unions, elbows, and tees; and O-rings. Pipe sizes range from $\frac{1}{8}$ to 2 in. Combination Pump Valve Co.

Circle D-41 on White Card





Spring steel retaining tabs 932 Spring steel retailing ensure positive seal between of Arco sheet metal and membrane of Arco grommet; 300 to 400 per cent ex-pansion of membrane provides positive seal around wires, rods, tubes, etc. Automotive Rubber Co. Inc.

Circle D-43 on White Card

in the booths . . .

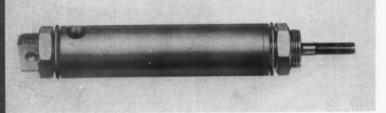
- Hansen Mfg. Co.— Hydraulic couplings 512 and hose clamps
- Wittek Mfg. Co .-Hose clamps
- Auburn Mig. Co.-Gaskets, packings, and O-rings
- 544 Parker-Hannifin Corp., Parker Fittings & Hose Div.-Tube and hose fittings, including new metal sealing ring and snap-in ferrule Hannifin Co. — Hydraulic and pneumatic cylinders, directional control valves, filters, regulators, and lubricators
- 549 Vickers Inc., Div. of Sperry Rand Corp.— Hydraulic power and control equipment: Pumps, servo valves, directional control adjustablevalves, speed hydraulic drives, filters, remote-control valves, and flow regulators
- Denison Engineering Div., American Brake Shoe Co. - Valves,

- pumps, and related equipment
- 616 Waukesha Foundry Co., Pump Div.-Stainless-steel pumps
- 618 Garlock Inc. Mechanical packings, gaskets, and seals
- Aeroquip Corp. Flexible hose and 619 formed tubing semblies, couplings, and fittings
- 632—National Tube Div., U. S. Steel Corp.— Mechanical tubing
- 709 Electric Boat Div. Dynamics General Corp. — Slotted-blade vaneaxial fans
- 742 International Packings Corp. Seals, packings, and gaskets
- Combination Pump Valve Co. — High-pressure valves and fittings
- Ohio Seamless Tube Div., Copperweld Steel Co. - Round,

- square, and rectangular tubing
- 825 Automatic Switch Co. -Solenoid valves
- 829 Mo-Bar Hydraulic Co. -Air cylinders, medium and high-pressure hydraulic cylinders
- DeLaval Steam Tur-bine Co. Rotary positive displacement pumps and hydraulic motors
- 839 Mead Specialties Co. - Pneumatic cylinders
- Skinner Electric Valve Div., Skinner Precision Industries Inc.— Solenoid valves
- 910 C. A. Norgren Co.-Filters, pressure regu-lators, lubricators, and valves
- 920 E. F. Houghton & Co.

 —Rod and cylinder
 packings and compatible fire-resistant hydraulic fluids
- Automotive F Co.—Sealants, Rubber sealing grommets, boots, and gaskets

Fluid Power (cont.)



1013 Miniature, heavy-duty 7%-in. bore cylinder is for 250-psi air, or 2500-psi hydraulic service. One-inch-stroke spring return and 1, 2, 3, 5, 7, and 9-in. double-acting models are available. Clippard Instrument Laboratory Inc.

Circle D-44 on White Card

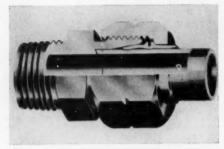
in the booths.

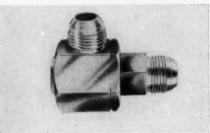
- AFCO Fitting Co., Div. of United States Air Compressor Co.-Hydraulic flared and flareless tube and pipe fittings and air line couplings
- Imperial Eastman Corp.—Pipe and tube fittings, hose, and couplings
- 960 Pall Corp. Pressure switches, mechanical seals, and filters
- 1005 Carter Controls Inc. -Air and hydraulic cylinders and rotary actuators
- 1013 Clippard Instrument Laboratory Inc.-Minicture pneumatic products
- Snap Tite Inc. Quick connect dis-1029 connect couplings
- Sealol Inc.—Mechan-1058 ical seals, miniature valves, ball valves
- 1105 Polymer Corp.-Nylon braided hose.
- 1108 Crawford Fitting Co. Quick-connect and ole quick-con-tube fitting multiple nect heat-exchanger tees
- 1110 Joyce-Cridland Co.-Hydraulic Cylinders.
- 1117 Screen Products Inc. -Strainers, filters. and screens
- Poxylube Inc.-Heatcure and air-dry solid lubricants
- Airmatic Valve Inc.-1152 Valves, cylinders, pumps, and C-clamps

- 1154 Humphrey Products Div., General Gas Light Co.—Valves
- 1200 Chemiquip Co.—Porous metal pressure snubbers
- 1202 OPW-Jordan Corp.-Pressure regulators, control valves, temperature regulators, and special valves and couplings
- Owatonna Tool Co., Precision Hydraulics Precision Hydraulics Div. — Single and double - acting hydraulic cylinders, hy-draulic hand pumps, and hydraulic power package
- 1224 Lisle Corp. Magnetic plugs and chip detectors
- Viking Pump Co.-Rotary pumps, special alloy pumps, and ceramic-fitted pumps
- Sigmamotor Inc. -Chemical - metering pumps, proportioning tubing pumps, and adjustable - speed transmissions
- Disogrin Industries-Solid polyurethane U-cups, cup packings, flange packings, and rod wipers
- 1236 Modern Industrial Plastics, Div. of Duriron Co. Inc.-Gas-
- 1243 Valcor Engineering Corp. Solenoid valves
- Industrial Div., Weatherhead Co.-Tube fittings hose assemblies

953 Symmetrical-machined sleeve of UF fitting ensures correct assembly to the body. After assembly, the sleeve becomes an integral part of the tube. Large contact area damps vibration and prevents critical stress concentration. AFCO Fitting Co.

Circle D-45 on White Card



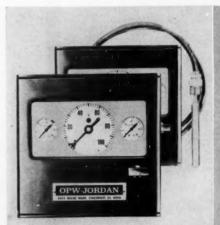


956 Pressure is equal against all internal surfaces and seals in a 360-deg swivel connector for pressures to 3000 psi. As internal pressure increases, cushioning effect be-tween swivel shaft and housing also increases. Imperial-Eastman Corp.

Circle D-46 on White Card

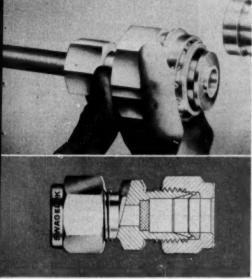
1202Response is precise (1 per cent at middle half of scale) in pneumatic controllers for pressures up to 10,000 psi and temperatures from -125 to 1000 F. Standard features include 1 to 100 per cent proportional band, manual reset, differential gap action and on-off snap action. OPW-Jordan Corp.

Circle D-47 on White Card



1029 For use in permanent installations, Rigid-Line quick-disconnect couplings permit quick addition or removal of valves, gages, pumps, or meters in fluid lines. Cadmium-plated steel, anodized aluminum, or type 316 stainless steel (passivated) couplings are available in ½ and 1-in. ID sizes. Snap-Tite Inc.

Circle D-48 on White Card



1108Damping effect of Swagelok Snubber tube fitting prevents damage to instruments caused by sudden flow surges in fluid lines. Standard tube fitting shapes are available, and the snubber element can be type 316 stainless steel or sintered bronze. Crawford Fitting Co. Circle D-49 on White Card

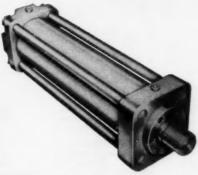
1152Squeezing controls flow of air or fluids without use of poppets or spools in Tube-O-Matic valve. An elastic rubber sleeve opens and collapses over the ends of inlet and outlet end plugs to start or stop flow. There are no metal-to-metal contacts or metal-to-rubber seals. Pipe sizes are ½ to 12 in.; maximum pressure rating, 200 psi. Airmatic Valve Inc.

Circle D-50 on White Card



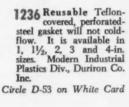
1243Radioactive chemical solutions are handled by solenoid valves available for use in pressure and vacuum systems. Standard pipe size is ½ in.; ¾ in. is available in special valves. Valcor Engineering Corp. gineering Corp.

Circle D-51 on White Card



1203Choice of stroke length is offered in YD series 10,000 psi, heavy-duty, double-acting hydraulic cylinders. Capacities range from 50 to 150 tons. Precision Hydraulics Div., Owatonna Tool Co.

Circle D-52 on White Card

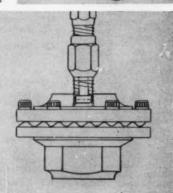




1154Precision-made, heavy-duty manual valves, available with side or bottom-mount bases, can be mounted in a tom-mount bases, can be mounted in a variety of positions. Seven 1/4-in. two and three-way models are available for manual and mechanical operation. Humphrey Products Div., General Gas Light

Circle D-54 on White Card





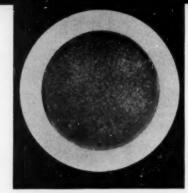
1200Sealed-system pressure snubber protects instruments in systems containing highly viscous or corrosive media. Thin diaphragm, isolating line fluid from the sealed system, transmits upscale or downscale equilibrium readings in 2 or 3 sec; porous metal snub-ber damps transients. Chemiquip Co. Circle D-55 on White Card

Electric, Electronic
Fluid Power

Materials, Processes, and Parts

Mechanical EquipmentAssembly Components

Engineering Department Equipment



801 Drawing and fabricating of Alstan aluminum-coated steel wire is possible because of the solid-phase bond between the two materials. Present maximum thickness of the electrically conductive aluminum coating (60 per cent of total cross-sectional area) provides 40 per cent of the conductivity of an equivalent size of copper wire. National-Standard Co.

Circle D-56 on White Card

in the booths . .

- 102 Cobehn Inc.—Highvelocity spray equipment and solvents for cleaning precision components
- 121 Cleveland Graphite Bronze Div., Clevite Corp.—Powdered titanium
- 125 Nylon Molded Products Corp.—Cast nylon parts
- 126 United States Plywood
 Corp. Laminated
 pamels, including metal-faced pamel; decorative asbestos-cement structural pamel;
 plastic coating; and
 cut-to-shape plywood
- 130 New Hermes Engraving Machine Corp.— Metal and plastics engraving machines
- 131 American Sealants Co.—Sealant for locking threaded fasteners and retaining bearings
- 143 Synthane Corp. Thermosetting laminated plastics
- 146 Dixon Corp.—Custom fabricated Teflon and reinforced TFE parts, slip and antistick agent
- 148 Glass Laboratories
 Inc. Plastic trim
 molding in satin and
 bright finishes
- 154 Chicago-Allis Mfg. Corp.—Molded rubber components
- 156 Continental Diamond Fibre Corp.—Laminated plastic and vulcanized fiber products
- 207 Cadillac Plastic & Chemical Co.—Stock shapes in nylon, TFE, polycarbonate, acetal, acrylic, and styrene

- 212 Permacel Pressuresensitive tapes, adhesives, sealants, coatings, and dispensers
- 215 Reynolds Metals Co.— Aluminum and applications, finishes for aluminum
- 221 Alloy Products Corp. —Stainless-steel deep drawings, stampings, shapes, fabrications, and weldments
- 237 Crane Packing Co.— Teflon shapes, bearing materials, and sealing compounds
- 301 Acme Steel Co.—Patterned steel strips, metal stitchers
- 304 Lancaster Glass Co.
 —Custom-made glass
 and plastic parts
- 306 Selectrons Ltd.—Highspeed selective plating
- 306 Marlane Development Co. Inc.—Highspeed selective plating
- 309 Clad-Rex Div., Simoniz Co. Vinyl-clad aluminum and steel
- 313 Aluminum Extrusions Inc.—Fabricated aluminum extrusions
- 319 Stokes Molded Products Div., Electric Storage Battery Co.— Plastic and hard-rubber molded parts
- 323 Arthur Tickle Engineering Works Inc.— Bimetallic costings and aluminum-coated parts
- 325 Universal Castings Corp.—Precision vacuum-cast, plaster-mold castings in brass, bronze, copper, and

- aluminum; supercharger wheels; instrumentation castings
- 332 Chemo Products Inc.
 —Fluorocarbon products and coated glass
 yarns
- 343 Instrument Specialties Co. — Beryllium-copper products
- 344 Toyad Corp. Expanded polystyrene, sponges and foams, custom-molded parts
- 357 Pennsylvania Fluorocarbon Co. Inc.— Shapes of Teflon
- 359 O'Sullivan Rubber Corp.—Injection-molded parts
- 405 Sandusky Foundry & Machine Co.— Centrifugally cast hollow cylinders of stainless and other steels, nickel and copper-base alloys
- 409 Armco Steel Corp.— Zinc-coated steel; stainless steel; highstrength, low-alloy steel; structural steel
- 416 Fasson Products Div., Avery Adhesive Products Inc.—Self-adhesive laminates, foil, and tapes
- 419 Avisun Corp.—Polypropylene products
- 421 National Vulcanized Fibre Co.—Glass-base laminated plastics
- 460 Casting Engineers
 Div., Consolidated
 Foundries & Mig. Co.
 —Precision investment castings
- 462 Owens-Corning Fiberglas Corp.—Glass fiber and insulating material
- 463 Rohm & Haas Co.— Acrylic plastic sheets

- and molding powder, high-impact acrylic molding powder, and polyester and acrylic-powder resins
- 500 Gleason Works—Bevel gear cutting machinery
- 511 Climax Molybdenum Co., Div. of American Metal-Climax Inc.— Molybdenum alloys
- 516 Handy & Harman— Aluminum and silver brazing alloys; silver alloys for electrical
- 519 Binks Mfg. Co.— Paint spraying equipment
- 520 Beryllium Corp.— Beryllium, beryllium oxide, and berylliumcopper alloys
- 525 Columbus Coated Fabrics Inc.—Vinylmetal laminates and vinyl fabrics
- 529 International Nickel Co.—Nickel and nickel alloys
- 536 Roehlen Engraving Works—Engraved embossing rolls, plates
- 542 Sylvania Electric
 Products Co., Parts
 Div.—Custom-modled
 plastics; custom metal
 stampings, welding,
 and assemblies; coiled
 printed metal
- 545 Doehler-Jarvis Div., National Lead Co.— Aluminum, brass, magnesium, and zinc die castings
- Minnesota Mining & Mig. Co. (Adhesives, Coatings, and Sealers Div.; Chemical Div.; and Reinforced Plastics Div.)—Ad-

146 Spray-on reinforced fluorocarbon slip and anti-slick agent produces low-friction, slick surfaces on metal, plastic, wood, and leather. Rulon Spray is also a lubricant and a mold release in plastic mclding. Dixon Corp.

Circle D-57 on White Card

306 Plating small areas is possible with Selectron equipment. Current is sent through the part to be plated; the cathode is clamped to the workpiece; and the anode (wrapped with cotton and saturated with electrolyte) is swabbed over the area to be plated. High current densities cause the metal to deposit quickly. Marlane Development Co. Inc. ly. Marlane Development Co. Inc.

Circle D-58 on White Card

156 High degree of flame retardancy, good punching and machining qualities, and solvent resistance are offered by a new NEMA G-10 glass fabric epoxy laminate. Di-Clad 614 is copper-clad for use in printed-circuit boards; Dilecto 614 is plain. Continental-Diamond Fibre Corp.

Circle D-59 on White Card

344 Self-extinguishing rigid urethane foam, Chemfoam RSF is made in two closed-cell types. RSF-6 has a density two closed-cell types, RSF-6 has a density of 5.5 lb per cu ft and flammability rating (ASTM D757-49) of 0.49 in. per min. RSF-2 has a density of 1.8 lb per cu ft and flammability rating of 0.54 in. per min. Toyad Corp.

Circle D-60 on White Card

416 Self-adhesive stainless-steel foil offers corrosion resistance, high strength, and excellent wearing properties. Flexibility of the 0.003-in. foil permits application to rounded surfaces. Fasson Products Div., Avery Adhesive Products Inc.

Circle D-61 on White Card

hesives; sealers; lamireinforced nated. plastics: corrosion-

- resistant plastic Kennametal Inc. Carbides and tungsten alloys
- La Salle Steel Co.allov High-strength steel bars
- Enjay Chemical Co.-Polypropylenes butyl rubbers and
- Olin Mathieson Chemical Corp., Metals Div.—Nonferrous alloys and fabricated parts
- 609 H. K. Porter Co. Inc.

 —Wire, rod and strip
 in copper-base, nickel-base, and stainless steel alloys
- Hungerford Plastics Corp.—Flexible vinyl moldings; flexible, rig-id, and extruded vin-610 Hungerford yl parts
- Ohio Rubber Co.— Custom molded and extruded rubber silicon and parts: polyurethane rubber goods
- Waukesha Foundry Co., Foundry Div.— Corrosion - resistant castings
- 618 Garlock Inc.-Plastic products
- Union Carbide Corp. (Haynes Stellite Co. (Haynes Stellite Co. Div.; National Carbon Co. Div.; Union Car-bide Metals Co.; Un-ion Carbide Plastics Co.; and Union Car-bide Chemicals Co., Textile Fibers Div.)—
 Vacuum investment
 castings, chemically etched parts, diffusion-coated parts; carbon and graphite

- structural shapes: ferroalloys, alloying metals, metal compounds; plastic resins and compounds; and acrylic fibers
- United States Steel Corp.—Alloy, high-strength, and stainless steels; forgings; bar semifinished products; vinyl coated sheet; pipe and tubes American Steel and Wire Div.—Wire products
- Dow Corning Corp.-Room - temperature-vulcanizing fluid silicone rubber
- Celanese Plastics Co., Div. of Celanese Corp. of America— Cellulose acetate, cellulose propionate, polyester resins, poly-ethylene, and acetate plastics
- Brush Beryllium Co.-Beryllium, beryllium oxide and beryllium copper products
- Mueller Brass Co. Brass, bronze, an and copper stock and paris
- American Smelting and Refining Co.— Continuous - cast bronze and aluminum and bronze casting alloys
- Poloron Production Vinyl-to-metal 716 laminates and molded expanded polystyrene
- Eastman Chemical Products Inc., Chemicals Div.-Fast-setting adhesives
- Aluminum Co. of American Vinylclad aluminum sheet, cellular structural aluminum, and anodized castings

421 Flame-retardant printed-circuit material, Phenolite grade G-10-866 is an epoxy-fiber glass laminate. It has excellent dimensional stability, chemical re-sistance, and electrical properties. Na-tional Vulcanized Fibre Co.

Circle D-62 on White Card

550 Only enough pressure to provide contact between parts being bonded and to keep them aligned is required by AF-110 thermosetting film adhesive. It provides metal-to-metal shear strengths in excess of 4000 psi at 75 F service temperature. Resistance to vibration, shock and water, oils, fuels, and salt spray is excel-lent. Adhesives, Coatings, and Sealers Dept., Minnesota Mining & Mfg. Co.

Circle D-63 on White Card

562 High malleability (10 per cent elongation) at tensile strength of 115,000 psi is exhibited by Kennertium, a heavy tungsten alloy. Three grades are available, with densities of 0.61, 0.65, and 0.67 lb per cu in. and hardnesses of 33, 29, and 35 Rockwell C. Kennametal Inc.

Circle D-64 on White Card

563 High-strength alloy steel bars, e.t.d. 150 and e.t.d. 180, are made by the Elevated-Temperature Drawing process. Minimum tensile strengths are 150,000 and 180,000 psi; with Rc 32 and Rc 83 hardness. Machinability of the 4100 series 0.40 min carbon alloy bars compares with annealed, cold-drawn 4140. LaSalle Steel Co. Circle D-65 on White Card

600 Long-term exposure to heat can be tolerated by Escon 125 polypropylene. Melting point is 335 F; material withstands 3 mo oxidative aging at 300 F.
The material is also resistant to chemical and stress cracking. It can be injection molded, extruded, drawn and vacuum

formed, heat-sealed, machined, and printed. Enjay Chemical Co., Div. of Humble Oil & Refining Co.

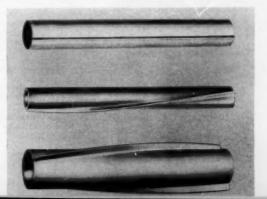
Circle D-66 on White Card

721 Vinyl-clad aluminum comes in 39 color-pattern variations in all sheet forms—coils, flats, circles, and blanks. Maximum width is 48 in.; thicknesses range from 0.016 to 0.051 in. Vynalate can be drawn, roll-formed, corrugated, munched ambessed crimed. punched, embossed, crimped, and expanded. Aluminum Co. of America.

Circle D-67 on White Card

849 One-piece construction of finned tubing provides high strength, constant physical and mechanical properties throughout, and resistance to corrosion. Straight, single-spiral, and double-spiral types can be made in sizes from 1/4 to 1/2-in. OD with wall thicknesses from 0.020 to 0.060 in. and fin heights from 0.010 to 0.100 in. Superior Tube Co.

Circle D-68 on White Card



Materials, Processes, and Parts

1059 Metal-bonded graphite parts are made from alloys of iron, nickel, cobalt, alluminum, and silver in 10 to 90 per cent graphite-to-metal ratios. Applications include bearings, seals, brushes, contacts. Dixon Sintaloy Inc. Circle D-69 on White Card



in the booths . . .

- 725 Marbon Chemical Div., Borg-Warner Corp.— ABS impactresistant plastics
- 737 Jones & Laughlin Steel Corp., Stainless and Strip Div.—Steel and steel products
- 742 International Packing Corp. — Molded rubber products
- 744 Hamilton Foundry Inc.
 —Iron castings
- 745 Dobeckmun Div., Dow Chemical Co.— Decorative coating and plastic films
- 762 United States Rubber Co. Mechanical Goods Div. — Royalite and expanded Royalite
- 763 Polychemicals Dept., E. I. du Pont de Nemours & Co. Inc.— Acetal resin, nylon, and acrylic resin
- 801 National-Standard Co.

 —Coated steel wire;
 vacuum-melted, nickel-base alloy wire;
 valve spring wire; other wire; wire cloth;
 perforated metal
- 810 McLouth Steel Corp.
 —Stainless and carbon steels
- 812 Eastman Chemical Products Inc., Plastics Div.—Polypropylene, polyethylene, butyrate, acetate, propionate, and polyester plastics
- 849 Superior Tube Co.— Tapered and finned tubing; small tubing of exotic metals and superalloys
- 856 Washington Steel
 Corp.—Plastic-coated
- 860 Film Dept., E. I. du Pont de Nemours & Co. Inc.—Cementable TFE film, polyester film, and PVF film
- 911 HPL Mig. Co., Melray Mig. Co., and HPL Jersey Co.—Stampings in small lots
- 912 Lord Mfg. Co.— Laminated material for controlling resonant response of printed circuitry

- 916 S. S. White Dental Mfg. Co., Industrial Div.—Plastic thread protectors
- 918 Raybestos Manhattan Inc.—Packing and gasket materials, rubber products, friction materials, adhesives
- 919 Colonial Rubber Co.

 Molded rubber components, siliconerubber moldings, reinforced rubber sheet
- 919 Connecut Rubber & Plastics Co.—Plastic cross sections, tubing, and sheeting
- 919 U. S. Stoneware Co.
 —Flexible plastic tubing, corrosion-resistant
 coatings, high alumina ceramics, and
 ceramic-metal seals
- 927 John Hassall Inc.— Cold-headed products
- 932 Automotive Rubber Co. — Rubber-insulated parts
- 937 Russell Burdsall & Ward Bolt & Nut Co.
 Custom molded thermoplastic and sintered-metal parts
- 938 Coating Products Inc.
 —Metalized plastic laminations
- 939 Spaulding Fibre Co. Inc.—Glass filament tubing, plastic laminates, and vulcanized fiber
- 944 Masland Duraleather Co.—Semirigid decorative vinyl surfacing for lamination to metals and hard boards
- 955 Decatur Casting Co.

 —Light gray-iron and alloyed iron castings
- 960 Pall Corp.—Molded fibrous glass; thermal, shock, and acoustic insulation materials
- 1012 Johnson Bronze Co.— Ferrous and nonferrous powdered metals, cast bronze and aluminum
- 1015 Maysteel Products Inc.
 —Fabricated sheetmetal products

- 1025 Hitchiner Mig. Co. Inc.—Investment costings
- 1028 Westchester Plastics Inc.—Colors in all types of plastic compounds for molding or extrusion
- 1032 B-Mold Div., Buckeye Brass & Mfg. Co.— Ferrous and nonferrous precision castings
- 1042 American Nickeloid Co.—Preplated and prefinished metals and vinyl-metal lami-
- 1045 Rigidized Metals Corp.—Texturized ferrous and nonferrous metals
- 1049 Metal & Thermit Corp. — Multicolor spray-on vinyl finish
- 1053 Hexcel Products Inc.

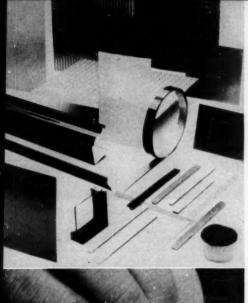
 —Metallic and reinforced plastic honeycomb
- 1057 Shwayder Bros. Inc.
 —Vinyl-metal laminates
- 1059 Dixon Sintaloy Inc.—
 Metal and graphite
 bonded materials and
 other powder-metal
 parts
- 1063 Mycalex Corp. of America Moldable ceramoplastic insulation material and parts, glass-bonded mica
- 1101 Fiberfil Inc.—Glassfiber reinforced thermoplastic materials
- 1105 Polymer Corp.—Plastic shapes and parts, plastic coatings
- 1111 Wolverine Tube Div.,
 Calument & Hecla
 Inc.—Titanium tubing,
 copper and copper
 alloys, special metals and aluminum,
 and aluminum shapes
- 1112 Foam Div., Scott
 Paper Co.—Polyurethane foam
- 1115 Mott Metallurgical Corp.—Porous, hightemperature metal components

- 1129 H. B. Fuller Co.— Epoxy adhesives, alloys, sealants, and coatings
- 1134 National Beryllia Corp.—Pure berylliam oxide components, transistor heat sinks and insulators, power tube heat sinks
- 1142 Amplex Div., Chrysler Corp.—Powdermetal parts
- 1143 Gries Reproducer Corp.—Die-cast and plastic-molded small parts
- 1147 Bendix Foundries,
 Bendix Corp.—Aluminum and magnesium castings
- 1156 Westplex Corp.— Molded nylon gears
- 1163 Janney Cylinder Co.

 —Ferrous and nonferrous centrifugal
 castings; nonferrous
 extruded shapes and
 die forgings; hard
 facing
- 1201 Metals & Controls
 Div., Texas Instruments Inc.—Precious
 clad metals: Strip,
 wire, and tubing
- 1234 Wall Colmonoy Corp.
 Brazing alloys, bonded-to-steel protective
 coatings, and hardsurfacing alloys
- 1251 Polygon Plastic Co.

 —Reinforced glass fiber rod stock and
 epoxy glass fiber tubing
- 1253 Lehigh Chemical Products Co. — Synthetic lubricants and oils
- 1256 Space Missile Materials Corp.—Special precision metal shapes; rings, discs, and bushings
- 1262 Coors Porcelain Co.

 —High alumina and
 beryllia ceramic and
 ceramic-to-metal assemblies



Plastic-coated stainless steel sheet combines corrosion resistance with decoration. ColorRold can be fabricated the same as uncoated steel without failure of the coating. Smooth and textured surfaces in 11 colors are available. Washington Steel Corp.

Circle D-70 on White Card



912 Damping is built into a printed-circuit-board material which reduces resonant transmissibility 50 to 66 2/3 per cent. Vibratory energy is converted into shear strains, which are dissipated in an elastomeric layer bonded between elements of epoxyfiber glass laminate. Dyna-damp can be used at -65 to 250 F, in extreme environments. Lord Mfg. Co.

Circle D-71 on White Card



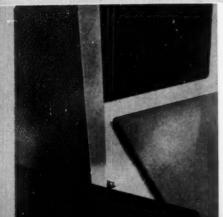
918 Teflon-reinforced asbestos sheet—designed primarily for gaskets—is made for regular or liquidoxygen service. Low cold flow characteristics allow use of Fluorobestos at continuous and cycling temperatures to 550 F. Low-temperature limit is —300 F. Raybestos-Manhattan Inc.

Circle D-72 on White Card



938 Continuous strip of decorative panels can be used for mechanical or manual applications. Die-cut panels, figures, or parts furnished on Ready-Strip are metallized Mylar with pressure-sensitive adhesive backing. Coating Products Inc.

Circle D-73 on White Card



1049 Textured, multicolored vinyl finishes are applied to fabricated phosphated steel or aluminum parts by a two-step spray system. Three or four spray passes of a wet film base coat are followed by three or four passes of top coat. Coatings Div., Metal & Thermit Corp.

Circle D-74 on White Card

860 Cementable Teflon FEP film can be attached—with common adhesives—to metals, plastics, elastomers, glass fiber, fabrics, asbestos, and paper. Film Dept., E. I. du Pont de Nemours & Co. Inc.

Circle D-75 on White Card

1063 Precision-moldable insulation material, Supramica 620 BB ceramoplastic is effective at extremely high temperatures. At 932 F, volume resistivity is 10⁸ ohm-cm. The material is impervious to oil, water, and organic solvents, and it will not carbonize. Mycalex Corp. of America.

Circle D-76 on White Card

1112 Skeleton network structure of Scott Industrial Foam makes it suitable for filtratio:, as well as for insulation and cushioning. This polyurethane foam is composed of a three-dimensional, random network of interconnecting strands. Six standard porosity grades are available, with 10 to 80 pores per lineal inch. Thickness can be up to 6 in. in 1/16-in. increments. Foam Div., Scott Paper Co.

Circle D-77 on White Card

1234 Only half the normal alloying time is required by Nicrobraze S series brazing alloys, which are applied by an air-gun or a manual syringe. The alloys are a mixture of powder in a high-viscosity vehicle. Stainless Processing Div., Wall Colmonoy Corp.

Circle D-78 on White Card



Electric, Electronic Fluid Power Materials, Processes, and Parts

Mechanical Equipment

Assembly Components

Engineering Department Equipment



137 Glass-fiber-filled nylon retainer reduces sliding friction in Nyla-Roll type NJ needle thrust bearing. Thrust capacity is equal to or greater than that of an all-steel bearing, and operating temperature is lower. Kaydon Engineering Corp.

Circle D-79 on White Card

in the booths

- 109 Hart Reduction Pulley Co.—Pulleys and accessories
- 117 Rollway Bearing Co. Inc. — Radial and thrust-type cylindrical roller bearings
- 118 New Departure Div., General Motors Corp. —Precision ball bearings; miniature and instrument ball bearings
- 121 Cleveland Graphite Bronze Div., Clevite Corp. — Bearings, bushings, and thrust washers
- 122 Controlex Corp. of America Ball-bearing remote controls
- 134 Dynamic Gear Co.
 Inc.—Standard and
 miniaturized gears
- 137 Kaydon Engineering Corp.—Standard and special ball and roller bearings
- 138 Martin Engineering Co.—Vibration inducers for moving material
- 144 Lignum-Vitae Products Corp.—Self-lubricating bearings, bushings, slides, guides, pulleys, and rollers
- 150 Stow Mfg. Co.—Flexible shafts, 90-deg gearboxes, and 300deg geared joint
- 205 Scully-Jones and Co.

 —Roller way bearings, ball screws,
 spring pads for way
 bearings
- 210 Arguto Oilless Bearing Co.—Impregnated wood bearings, molded plastic bearings
- 213 Aetna Ball & Roller Bearing Co.—Bearing chain, sprocket idlers,

- and straight roller bearing cages
- 223 Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co.— Flexible couplings
- 224 Fawick Airflex Div., Fawick Corp.— Clutches
- 245 Eriez Mfg. Co.—Vibratory feeders and permanent magnets
- 247 Web Controls Corp.
 —Clutches, brakes,
 and transmissions
- 251 Browning Mfg. Co.— Adjustable - speed drives and bearing units
- 308 Worthington Corp.—
 Mechanical power transmission products
- 322 Dodge Mfg. Corp.—
 Flexible cushion couplings, dry-fluid drives and couplings, pillow blocks, speed reducers, drives, sprockets, and roller chairs.
- 342 Boston Gear Works

 —Gears, speed reducers, sprockets and chain, bearings, universal joints, and couplings
- 346 Maurey Mig. Co.— Sheaves, V-belts, and pulleys; roller and conveyor chain; tensioning device for chain and belt drives
- 362 Roller Bearing Co. of America—Roller bearings and bushings
- 400 United Shoe Machinery Corp.— Constant-ratio drive with reduction ratios to 40,000:1; power servomechanism drives, and other transmissions

- 401 Duff-Norton Co.—Lifting jacks and hoists
- 410 Beaver Precision
 Products Inc. Bearings, ball screws, ball
 splines, ball ways,
 and high-capacity
 jack systems
- 412 Mono Race Div., Thew Shovel Co.— Custom and standard bearings
- 444 Foote Bros. Gear & Machine Corp.—
 Gears, gearmotors, speed reducers, and power transmission equipment
- 501 Warner Automotive Div., Borg-Warner Corp.—Gears and gearboxes
- 505 Prudential Industries
 Inc. (Atlas Chain &
 Mfg. Co. and Atlas
 Precision Products)—
 Roller chain, sprockets, couplings, precision stock gears, differentials, gear trains,
 and electromechanical assemblies
- 540 Auburn Mfg. Co.— Washers, installation parts, adhesive film preforms, color-coded plastic shims
- 656 Eaton Manufacturing Company, Cleveland Worm & Gear Div.— Worm gears and worm-gear speed reducers
- 736 Formsprag Co.— Clutches, torque-locking and positioning devices
- 743 Link-Belt Co.— Power-transmission equipment
- 743 Syntron Co.—Electromagnetic vibrators and feeders, and related components

138 Permanent-mount highamplitude vibration inducers have high power-toweight ratio. Five sizes provide speeds from 100 to 8000 rpm, according to application, Martin Engineering Co.

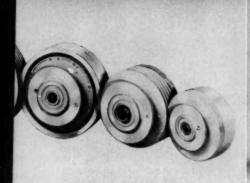
Circle D-80 on White Card

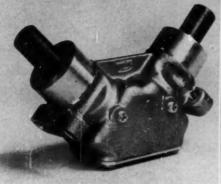




213 One-piece, sealed-ball-bearing chain idler is available in a variety of tooth configurations. Rubbing rubber type seals keep lubricant in place, and tooth configuration provides positive drive of idler. Aetna Ball & Roller Bearing Co.

Circle D-81 on White Card







109 Two and three-speed gear reduction pulleys have internal gear reductions from 1:999 to 1457:1; special types have up to 8000:1 reductions. Pulleys are from 10 to 40 in. diam. Hart Reduction Pulley Co.

Circle D-82 on White Card

150 Sharp bends in rotary-type remote-control linkages are made with this 90-deg gear box which has bevel gears supported in needle bearings. Three sizes offer torque capacities of 500, 2000, and 3500 lb. Efficiency is about 88 per cent. Stow Mfg. Co.

Circle D-83 on White Card

251 Locking-ring assembly will not work loose in MVP adjustable-speed sheaves for drives up to 125 hp. Concentric grooves and flanges that do not rotate in adjustment are also features. Browning Mfg. Co. Circle D-84 on White Card

656 Fan cooling, centrifugally cast bronze gears, and hardened-thread worms are features of worm gear speed reducers with ratios from 4:1 to 3600:1. Single, helical, and double-reduction worm types with horizontal and vertical shafts are available. Cleveland Worm & Gear Div., Eaton Manufacturing Company

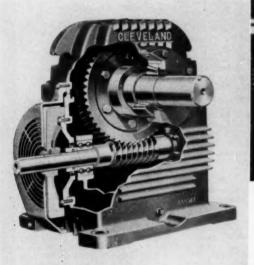
Circle D-85 on White Card

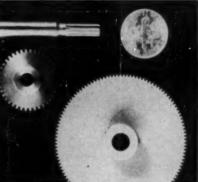
410 Ball spline adds rigidity without impairing efficiency of ball-screw mechanism.

Nuts of both screw and spline are encased and preloaded in a single cast-aluminum housing.

Beaver Precision Products Inc.

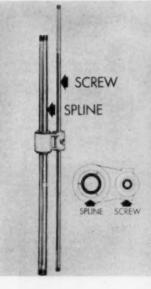
Circle D-86 on White Card





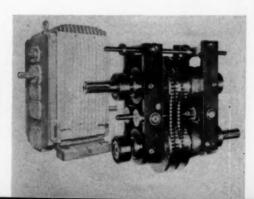
342 Fine-pitch precision spur gears range in sizes from 1/10 to 21/4 in., with 48 to 120 DP—10 to 40 teeth in stainless steel, and 42 to 180 teeth in aluminum. Gears are certified AGMA Precision Class 1 or better. Boston Gear Works

Circle D-87 on White Card



743 Compact adjustable-speed drives in RS P.I.V. series have ratings up to 50 hp. Five available types are basic drive or basic drive combined with output gears, input gears, and integral foottype motor. Link-Belt Co.

Circle D-88 on White Card

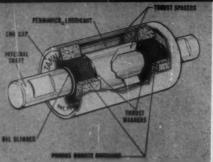


Mechanical (cont.)



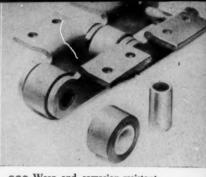
800 Infinite positioning and positive locking permit a variety of positioning applications for the Linear Positioning-Lock. Movement in one direction is spring-powered when lock is released. Roton Products Div., Anderson Co.

Circle D-89 on White Card



924 Permanent recirculatory lubrication is built into 20,000-hr shaft bearings. They handle 25 to 30 lb radial load at moderate thrusts and are available in shaft sizes of 3/8, 1/2, and 5/8-in. diam. Tann Bearing Co., Tann Corp.

Circle D-90 on White Card



929 Wear and corrosion-resistant Delrin-bushed rollers are combined with stainless-steel bushings in Chabelco conveyor chain. Chains range from 3 to 6 in, pitch. Chain Belt Co.

Circle D-91 on White Card

in the booths . . .

- 800 Roton Products Div., Anderson Co.— Reclining seat lock and antifriction bearing screw
- 836 DeLaval Steam Turbine Co.—Worm-gear speed reducers
- 842 Morse Chain Co., A Borg-Warner Industry —Roller silent chain, sprockets, couplings, clutches, speed reducers, torque limiters, and stock gears
- 843 Heim Co.—Spherical, rod-end, and ball bearings
- 844 Spiroid Div., Illinois Tool Works—Medium -to-high, low-to-high, and low-ratio rightangle reduction gears
- 845 Saginaw Steering Gear Div., General Motors Corp.—Ballbearing screws and splines
- 857 Hunter Spring Co.,
 Div. of American Machine & Metals Inc.—
 Constant-force springs
 and constant-torque
 spring motors
- 901 T. B. Wood's Sons Co.

 —Belted transmission drives, including new multiple-groove, stationary-control, adjustable-speed unit
- 904 Barry Controls Inc.— Shock and vibration controls
- 916 S. S. White Dental Mfg. Co., Industrial Div.—Flexible shafts
- 924 Tann Corp.—Shaft bearings, sleeve bronze bearings, and sealed circulating oil pillow blocks
- 929 Chain Belt Co.—Selfaligning roller bearings, roller chain,

- conveyor chain, and sprockets
- 943 Thomas Flexible
 Coupling Co. Allmetal flexible couplings for power transmission, including
 miniature and subminiature sizes
- 958 Sier-Bath Gear & Pump Co. Inc.—Spur and helical gears, planetary drive
- 962 Thomson Industries
 Inc.—Ball bushings,
 linear ball bearings,
 precision bearings,
 and case-hardened
 and ground shafts
- 1000 Industrial Tectonics Inc.—Precision balls and bearings
- 1001 Sterling Instrument
 Div., Design-Attonics
 Electromechanical
 components, including speed reducers,
 magnetic clutches and
 brakes, and precision
 gears
- 1004 Acme Chain Co.— Offset side-bar and circular power-transmission chain
- 1011 Arch Instrument Co. Inc.—Precision differentials, standard and precision gears, mechanical and electromechanical gear assemblies
- 1012 Johnson Bronze Co.— Sleeve bearings: bimetallic and strip, babbit on steel or on bronze, bronze on steel, rolled bronze
- 1016 Randall Graphite Bearings Inc.—Pillow blocks, plain and graphited bronze bushings, cored and solid bronze bars, and bearing cartridges
- 1017 Dayton Industrial

- Products Co., Div. of Dayco Corp.—V-belt drives and V-belts
- 1020 Orange Roller Bearing Co. Inc.—Needle, staggered-roller, and journal-roller bearings; cam followers; cam yoke rollers; thrust roller bearings
- 1031 McGill Mfg. Co. Inc.
 —Heavy-duty needle
 roller bearings
- 1039 Snow-Nabstedt Gear Corp.—Transmissions, speed reducers, speed increasers
- 1044 Lovejoy Flexible
 Coupling Co.—Totally
 enclosed adjustablespeed drives, universal joints, variable
 pulleys, and flexible
 couplings
- 1060 Nice Ball Bearing Co.
 —Standard and miniature ball bearings,
 automotive bearings,
 and special-purpose
 bearings
- 1062 Hoover Ball and Bearing Co.—Ball and roller bearings, pillow blocks
- 1110 Joyce Cridland Co.— Worm-gear jacks
- 1120 Hilliard Corp.—Single-revolution clutches, over-running clutches and clutch couplings, slip clutches and clutch couplings, centrifugal clutch couplings
- 1132 General Bearing: Co.

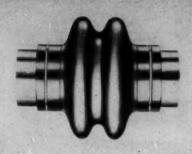
 —Unground ball bearings, special bearings, preassembled rollers and studs
- 1136 Ohio Gear Co.— Single - reduction worm gear reducers
- 1142 Amplex Div., Chrysler Corp.—Self-lubri-

- cated bearings
- 1144 Cullman Wheel Co.— Sprockets, flexible couplings, and roller chain
- 1147 Bendix Corp., Eclipse
 Machine Div.—Electromagnetic clutches
 and brakes
- 1160 Landis & Gyr—Miniature ball and roller bearings
- 1161 Simplatrol Products Corp.—Electric clutches and brakes
- 1205 Hartford Steel Ball Co.—Balls and ball bearings
- 1212 American Stock Gear Div., Perfection Gear Co.—Speed reducers, gearmotors, gears, universal joints, flexible couplings
- 1219 Curtiss-Wright Corp., Marquette Div.— Spring clutches
- 1228 Diamond Chain Co... Inc.—Roller and conveyor chain and couplings
- Modern Industrial Plastics, Div. of Duriron Co. Inc.—Bearings
- 1241 Manheim Mfg. & Belting Co.—V-belting: Adjustable link-type belt, variable speed belt
- 1244 Winsmith Inc.—Speed reducers
- 1246 Warner Electric Brake & Clutch Co.—Clutches, packaged clutchbrake drive, extended armature hubs for fractional - horsepower units, splined components
- 1254 Paramount Textile Machinery Co.—Electromechanical linear controls



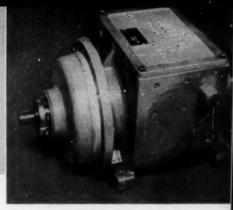
1011 Interchanging of end gears is possible in two ½-in. hollow-shaft mechanical differentials. Working-circle diameters are 0.880 and 1.032 in., and widths across inside face of end gears are 0.500 and 0.563 in. Arch Instrument Co. Inc.

Circle D-92 on White Card



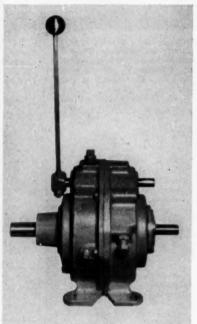
1044 Booted universal joint is for severe service (applications involving heavy loads, high speeds and/or heat, contaminants, difficulty of lubrication). Joint is prepacked with grease and operates through a full 40-deg working angle. Lovejoy Flexible Coupling Co.

Circle D-93 on White Card



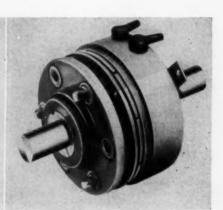
1120 Intermittent drive unit is a single-revolution clutch packaged with nec-essary controls. Capacities are up to 250 lb-ft, and operating speeds range from 50 rpm min to 250 or 300 rpm max. Hilliard Corp.

Circle D-94 on White Card

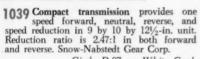


1161 Fixed-field electric clutch, Size 130, has static torque rating of 40 lb-ft. Flexible-diaphragm design eliminates sliding splines or pins in the armature. Simplatrol Products Corp.

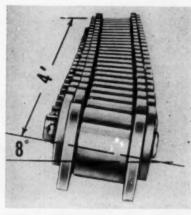
Circle D-95 on White Card



1246 Simplified mounting, high torque for size, and no need for slip rings or brushholder are features of SF 500 stationary-field clutch. It is a nominal 5 in. in diameter, and has a torque rating of 50 lb-ft. Warner Electric Brake & Clutch Co. Circle D-96 on White Card



Circle D-97 on White Card



1228 Straight-link power transmission chain is for heavy-duty applications. Its 4-in. lateral displacement from center line and 8 deg of twist per 4 ft accommodate sprocket misalignments. Diamond date sprocket Chain Co. Inc.

Circle D-99 on White Card

842 Twenty-degree pressure angle gears in the 3 to 20 pitch range are available in spur, bevel, miter sets (both straight and spiral), helical, and worm-and-gear sets. Sets are interchangeable with 14½-deg sets. Morse Chain Co.

Circle D-98 on White Card

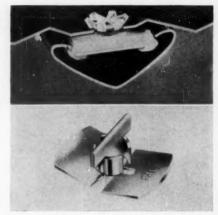
Electric, Electronic
Fluid Power
Materials, Processes,
and Parts
Mechanical Equipment

Assembly Components

Engineering Department Equipment

103 One-piece, self-retaining Sunburst fastener is installed and locked from one side. A good insulator, the plastic fastener is suitable for use with electrical components and wire retaining straps. Robin Products Co.

Circle D-100 on White Card



115 Barrel shank of lightweight quarter-turn blind fastener keeps it centered in its hole and adds shear resistance. Fastener is self-retaining. Palnut Co., Div. of United-Car Fastener Corp.

Circle D-101 on White Card

in the booths . . .

- 100 Weckesser Co.—Nylon fusieners and plastic cable clips
- 103 Robin Products Co.— One-piece, self-retaining fasteners
- 115 Palnut Co., Div. of United-Carr Fastener Corp.—Locknuts, selfthreading nuts, quarter-turn fasteners, integral acorn and washer-base nuts
- 116 Laminated Shim Co.
 Inc.—Titanium and
 stainless-steel laminated shims
- 140 Lamson & Sessions Co.—Hook-knurl bolts
- 142 Westline Products
 Div., Western Lithograph Co.—Markers
 for wire identification
- 218 Heyman Mfg. Co.— Nylon snap, strainrelief, and junctionterminal bushings; nylon hole plugs
- 231 Ohio Knife Co. Ways, gibs, die sections, and knives
- 242 MacLean-Fogg Lock Nut Co.—Lock nuts and screws, prevailing-torque lock nuts,

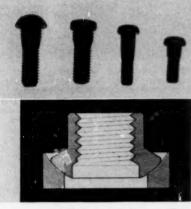
- flange-type nuts, and projection weld nuts
- 243 Veeder Root Inc. Counters
- 321 W. H. Brady Co. —
 Self-adhesive plastic
 and aluminum nameplates
- 331 Star Expansion Industries Corp.—Fasteners and fastening devices
- 337 Rosan Inc. Ringlocked inserts and studs, thin - walled locking inserts, and self-clinching parts
- 340 PIC Design Corp.— Precision instrument parts and components, precision tool components
- 345 Tinnerman Products Inc. — Spring - steel lock nuts
- 350 Tubular Rivet & Stud Co.—Standard and special rivets, riveting machines
- 362 Roller Bearing Co. of America — Tolerance rings
- 400 United Shoe Machinery Corp. — Large flange-type rivets and eyelets

- 420 B. F. Goodrich Aviation Products, Div. of B. F. Goodrich Co.—Blind fasteners
- 428 Dzus Fastener Co. Inc.
 —Spiral-cam, supersonic, panel, universal, and buttressthread fasteners, and clamps
- 440 Nylok Corp. Selflocking bolts, screws, and nuts
- 445 Associated Spring Corp.—Precision mechanical springs
- 451 Parker-Kalon Div.,
 General American
 Transportation Corp.
 Tapping screws,
 socket screws, screwnails, weld screws,
 and socket setscrews
- 610 Ohio Rubber Co. Rubber wheels and tires
- 458 Chart-Pak Inc.—Pressure-sensitive tapes, labels, and die-cut symbols
- 656 Eaton Manufacturing Company [Farval Div., Reliance Div.)— Lubrication systems; tamperproof fasteners,

- lock nuts, and preassembled screw and washer assemblies
- 720 Elastic Stop Nut Corp. of America — Selflocking fasteners
- 809 Ferry Cap & Set Screw Co.—Externalwrenching, precision, 12-point, alloy steel screws
- 815 Standard Pressed Steel Co. — Stainless steel fasteners, selfaligning lock nuts, press nuts, self-locking nuts, and highfatigue tension fasteners.
- 821 Falstrom Co. Electronic rack cabinet
- 835 American Screw Co.
 —One-piece multiplescrew assembly, tamperproof screws, and high-torque aircraft fasteners
- 844 Shakeproof Div., Illinois Tool Works—
 Sealing fasteners,
 lock washers, lock
 nuts, preassembled
 screw and washer assemblies, tapping
 screws, and other
 fastening devices

140 Knurls set on a spiral in Hook Knurl bolt produces a body-bound fit in the connected material. The bolt head need not be held during assembly of the nut, and it will not push out of the hole if lock nuts are used. Lamson & Sessions Co.

Circle D-102 on White Card



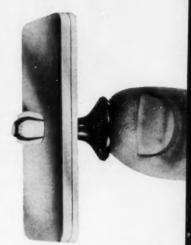
815 Self-aligning lock nut, SPS SA 16, compensates for out-of-perpendicular seating surface. Bearing pressure between spherical alignment washer and nut is con-stant at all angles up to 8 deg. Standard Pressed Steel Co. Circle D-103 on White Card

428 High-strength quick-operating fastener has buttress thread configuration and floating receptacle. Dzus Fastener Co. Inc.

Circle D-107 on White Card







915 Thumb pressure applied to grommet and plunger installs captivated Nylatch fas-tener. Floating grommet allows for misalignment of holes with up to 0.020-in. radial float (0.040 in. total). Hartwell Corp. Circle D-110 on White Card

142 Partly transparent vinyl-film wire marker becomes self-lami-nating during application. Transparent extension wraps around precoded area, extension wraps around precoded area, providing protection from oil, grease, chemicals, and other fluids. Westline Products Div., Western Lithograph Co. Circle D-108 on White Card

720 Miniature floating clinch nut for blind fastening provides loadbearing threads in thin sheetnetal assemblies. Two small lugs retain the nut in a window-type basket, providing 0.020-in. radial float. Elastic Stop Nut Corp. of America

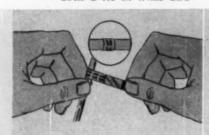
Circle D-111 on White Card

116 Titanium laminated shims are made of 0.003-in. layers of pure titanium bonded to each other, or to a thicker sheet of titanium alloy. Shims are custom-made to specifications. Laminated Shim Co. Inc.

Circle D-104 on White Card

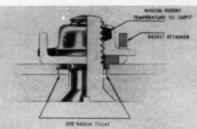
821 Electronic rack cabinet of heavy-gage cold-rolled steel or alumi-num measures 24 by 24 by 77 in. high. Adjustable channels facilitate mounting slides or chassis, and the venti-lating system can be tailored to meet requirements. Falstrom Co.

Circle D-105 on White Card



Strength is doubled in turnedback, crimped rim of lock washer for use in assemblies subjected to high torque and tension. Also used for sealing, the folded-rim washer prevents thread leakage under high pressure and at temperatures to 500 F. Shakeproof Div., Illinois Tool Works

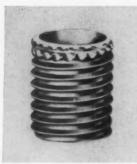
Circle D-109 on White Card





Tamperproof Tri-Wing screw is easily installed and removed with simple driver bit. It is made in a wide range of sizes, types, and materials. American Screw Co.

Circle D-112 on White Card



1010Thin-wall, high-strength insert is lightweight and resistant to corrosion. Installation does not require use of special taps or gages in preparation of the receiving hole. Kaynar Mfg. Co. Inc.

Circle D-113 on White Card



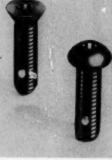
1018 Heavy-duty retaining ring, designed for assemblies subjected to extreme loading conditions, has high thrust and impact resistance. Shoulder of the Truarc series 5160 is high enough to retain components having large corner radii or chamfers. Waldes Kohinoor Inc.

Circle D-114 on White Card



1021 Spring-ejected and held in full retraction when disengaged, No. 53 access panel fastener permits doors or chassis panels to slide past one another. It is available in stainless steel in seven thread sizes, from 8-32 to ½-28, and three head sizes. Southco Div., South Chester Corp.

Circle D-115 on White Card



1036Fluted-socket screws are available with Nylok self-locking insert. The vibration-resistant fasteners are furnished in a variety of sizes. The Bristol Co.

Circle D-116

D-116 on White Card

Assembly Components (cont.)

in the booths . . .

- 857 Hunter Spring Co., Div. of American Machine & Metals Inc.— Precision springs, wire forms, stampings, and assemblies
- 905 Avery Label Co.— Pressure - sensitive nameplates, labels, and decorative products
- 915 Hartwell Corp. —
 Quick-release fasteners, pins, and latches,
 and Velcro
- 937 Russell, Burdsall & Ward Bolt & Nut Co.
 Cold headed special fasteners; aluminum, silicon bronze, and stainless-steel fasteners
- 947 Park Nameplate Co., Div. of Park Electrochemical Corp.—Anodized, etched and embossed decorative aluminum trim
- 957 Simmons Fastener Corp. — Quick - operating fasteners and katches
- 1010 Kaynar Mig. Co. Inc.
 —Self-locking nuts
 and inserts

- 1015 Gleason Reel Corp.— Cable and hose reels
- 1018 Waldes Kohinoor Inc.

 —Retaining rings, applicators, and dispensers
- 1021 Southco Div., South Chester Corp.—Special fasteners for doors, pamels, etc.; quarter-turn aircraft fasteners; latches; pawl fasteners; screw fasteners; and rivets
- 1036 Bristol Co.—Socket
- 1038 Faultless Caster Co.

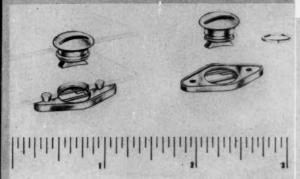
 —Casters and wheels
- 1043 Heli Coil Corp. Stainless steel screwthread inserts, screwlock inserts, expansion inserts, and nuts
- 1100 Edwin B. Stimpson Co.—Eyelets, grommets and washers, snap fasteners, plugs, rivets, terminals, stampings, and attaching machines
- American Optical Co.
 —Signature code and decoder equipment, flexible fiberscope, cathode-ray tube face plate with fiber optics

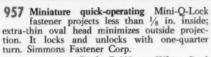
- 1213 Penn Engineering & Mig. Corp. Self-clinching fasteners
- 1215 Ramsey Corp. Spiral - wound and stamped retaining rings
- 1218 Chicago Rivet & Machine Co.—Rivets and riveting machines
- 1220 Reed & Prince Mfg. Co.
 —Screws and threaded rods
- 1221 Groove-Pin Corp. Drive studs and selftapping, self-locking inserts
- 1223 Corbin Cabinet Lock
 Div., American Hardware Corp. Flushcup, drop, lever, and
 tee handles; quickrelease fasteners and
 locking devices for
 cabinets and panels
- 1242 Carr Fastener Co., Div. United-Carr Mfg. Corp.—Fasteners for molding, tubing, and wiring; panel fasteners, plug buttons, and washer nuts
- 1257 Moeller Mig. Co.— Stoppers

947 Three-dimensional, multicolored anodized aluminum nameplates, dial and control panels, and trim are available in 0.005 and 0.008-in. gages. Adhesive-coated and flexible, Thinplate Dimensional foll can be mounted on curved surfaces. Park Nameplate Co.

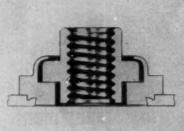
Circle D-117 on White Card

1015 Protection of electric cords to power hoists and similar equipment is provided by the Econoreel. Two models accommodate up to 20-amp cord, 25 to 45 ft long, in No. 18 to 12 wire sizes with 2, 3, or 4 conductors. Gleason Reel Corp. Circle D-118 on White Card





Circle D-119 on White Card



1213 Clinched by squeezing into a prepared hole, floating, self-locking fastener provides a rapidly assembled nut anchor in sheet metal. It compensates for 1/32-in. misalignment of mating holes. Penn Engineering & Manufacturing Corp.

Circle D-120 on White Card



1223 Flush-mounted cup and drop handle is available with various cams for one, two, or three-point locking mechanisms. Antirattle feature is optional. Corbin Cabinet Lock Div., American Hardware Corp. Circle D-121 on White Card

1038 Resilient polyurethane caster wheels resist abrasion, most acids, dry heat to 250 F, and cold to -90 F. Sizes from 5 to 12 in. are for 800 to 3500-lb loads. Faultless Caster Corp.

Circle D-122 on White Card

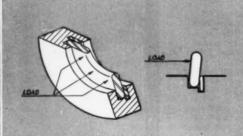
1215 Increased thrust capacity by better distribution of force across the groove wall is provided by Groove Guard, a thin, single-turn wound ring used with a retaining ring. Plastic flow of groove material is eliminated. Ramsey Corp.

Circle D-123 on White Card

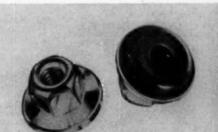
1242 Tough plastisol sealer in one-piece Dot washer nut has excellent ad-hesion, prevents leaks, and withstands severe abrasion. Metal-to-metal contact provides excellent torque retention. Carr Fastener Co., Div. United-Carr Fastener Corp.

Circle D-124 on White Card









1221 Thread forming without chips is accomplished in soft metal by Tap-Lok self-tapping insert. Threads are Lok self-tapping insert. Threads are formed by narrow, threaded lands on the insert, and the metal flows around the insert as it is driven in. Groov-Pin Corp. Circle D-126 on White Card

1043 Tightly wound coils of Push Insert provide the correct pitch when installed in a molded or drilled hole. Hav-ing no driving tang, the insert can be installed either end up. Heli-Coil Corp. Circle D-125 on White Card

Electric, Electronic Fluid Power Materials, Processes, and Parts Mochanical Equipment Assembly Components

Engineering Department Equipment



620 Four, six, or eight-tube units in Moducor rolled-file system house 4, 25%, or 11%-in. diam tubes. Interlocking modules are all 1834 in. wide, and lengths are 24 to 60 in., in 6-in. increments. Hamilton Mfg. Co.

Circle D-127 on White Card

in the booths . . .

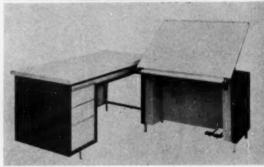
- 104 Rotherm Engineering
 Co. Inc. (Boyle Engineering Laboratory
 Div.) Testing, research, and development
- 123 FAC Div., Oversects
 Commodex Inc.—Engineering instruction
- 200 Ozalid Div., General Aniline & Film Corp. —Drafting table, whiteprinters
- 210 Arguto Oilless Bearing Co.—Bearing test
- 321 W. H. Brady Co.— Printed-circuit tapes and shapes, self-sticking printed wiring diagrams, layout and drafting tapes
- 340 PIC Design Corp.— Breadboard development kits
- 418 Stacor Equipment Co.
 —Drafting equipment
- 550 Minnesota Mining & Mig. Co. Microfilm reading, printing, mounting, and copying equipment
- 620 Hamilton Mfg. Co.— Roll-file system
- 704 General Motors Research Laboratories— Lip seal testing machines

- 709 Electric Boat Div., General Dynamics Corp. — Training devices and design and engineering services
- 732 Mayline Co. Inc.— Wood and steel drafting tables, plan files, and drafting supplies
- 857 Hunter Spring Co., Div. of American Machine & Metals Inc.— Testers, mechanical pull force gages
- 857 Riehle Testing Machines Div., American Machine & Metals Inc.
 —Force and distance measuring instrumentation with a wide range of readout and recording instruments
- 857 United States Gauge Div., American Machine & Metals Inc.— Gages, Bourdon tubes and diaphragms, super gages, and pilots
- 942 Draft a Matic Div., General Fireproofing Co.—Metal drafting desks
- 1127 Unitech Corp. Coordinate plotter and accessories
- 1131 Plan Hold Corp. Vertical and roll files
- 1147 Bendix Corp., Computer Div. Data-processing equipment
- 1238 Pack Mfg. Co.—Modular, interlocking drawing files

200 Any dry diazo sensitized material up to 19 in. wide can be processed at speeds up to 60 fpm in Super Ozamatic whiteprinter. It is 28½ in. high, 40 in. wide (including feedboard), and 24½ in. deep. Ozalid Div., General Aniline & Film Corp.

Circle D-128 on White Card





418 Easy adjustment of board height (from 30-in. desk height to 45 in.) and angle (from 0 to 90 deg at any height) is controlled by front pedals on Duo-Matic L drafting desk. Reversible feature allows assembly for right or left-hand use. Stacor Equipment Co.

Circle D-129 on White Card



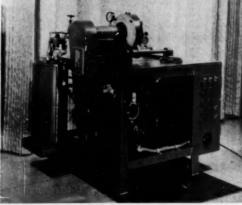
857 Tension and compression loads applied to the same end fitting are measured by in-line Push-Pull Force Gage. It is available in ranges from 0-10 to 0-250 lb. Accuracy is 1 per cent of maximum scale reading. Hunter Spring Co., Div. of American Machine & Metals Inc.

Circle D-130 on White Card

113 Self-adhesive strip is part of single-sheet hanger for vertical file. Press-board hangers, in 18 and 36-in. lengths, can be cut to any length with scissors. A new adjustable rack holds 150 hangers. Plan Hold Corp.

Circle D-131 on White Card





704 Simulation of operating conditions in Sealrater lip seal rating machine permits endurance, acceptance, and performance testing. It accommodates two seals up to 10 in. diam; a model that rates 12 seals is also available. General Motors Research Laboratories

Circle D-132 on White Card

Publications and Societies

- 111 Lead Industries Association—Lead products and examples of applications and lead technology
- 204 Drop Forging Association—Forged components illustrating new design techniques
- 236 Battelle Memorial Institute
- 263 Product Engineering
- 305 Gray Iron Founders'
 Society Inc. Gray
 and ductile iron castings; testing equipment to demonstrate
 compressive strength
- 320 Space/Aeronautics
- 329 Alloy Casting Institute — Heat-resistant and corrosion-resistant high alloy castings
- 349 Chilton Co.
- 363 MACHINE DESIGN
- 363 Automation
- 363 Foundry
- 363 New Equipment Digest
- 363 Steel
- 528 Copper & Brass Research Association— Copper and brass mill products, copper labeling
- 663 Sweet's Catalog Service, Div. of F. W. Dodge Corp.

- 700 Malleable Castings Council
- 700 Malleable Founders
 Society Malleable
 iron castings
- 710 Product Design & Development
- 712 American Zinc Institute Inc.—Design features of galvanized, die-cast, and rolled zinc
- 756 Design News
- 826 Metal Powder Industries Federation — Powder metallurgy parts and case histories
- 963 Materials in Design Engineering
- 1009 Technical Services
 Div., Rogers Publishing Co.
- 1040 Precision Metal Molding
- 1040 Industrial Publishing Corp.
- 1047 Malayan Tin Bureau
 —Consumer and commercial items illustrating characteristics
 of tin alloys
- 1137 Hitchcock Publishing
- 1209 Industrial Press
- 239 Thomas Publishing Co.
- 1253 American Society of Mechanical Engineers

363 MACHINE DE-SIGN invites all show visitors to stop in, talk to the editors, look at issues and reprints, or use our chairs.



Design Engineering Conference

More papers are scheduled for the Sixth Design Engineering Conference than were presented at any of the previous conferences—a panel discussion on Monday will be followed by 22 additional papers, to be heard during the next three days. The technical sessions, sponsored by the American Society of Mechanical Engineers, will be held in meeting rooms in Cobo Hall. Hours are 10 a.m. to noon on Monday, and 9:30 a.m. to noon, Tuesday through Thursday.

Monday's subject, "Designing for Today's Competitive Market," will be discussed by four representatives of the automotive industry. Concurrent sessions on Tuesday will cover ways to reduce manufacturing costs, automatic equipment, glass and ceramics, and high-strength steel. Wednesday's subjects are motors, costsaving in production, adhesives, fasteners, and powder-metal parts. On Thursday, subjects will be plastics, vibration, gearing, and lubrication.

A luncheon will be held Wednesday at Cobo Hall under the auspices of the ASME Machine Design Division.

Registration fee for the Conference (which includes copies of all papers and admission to the Show) is \$10 for ASME members and \$15 for nonmembers. Admission to the Show alone is \$2. The registration desk will be open from 8 a.m. until 5:30 p.m. every day.

Monday, 10:00 a.m.

Panel-Designing for Today's Competitive Market

Engineers in almost every industry are faced with the problem of designing to meet increasing domestic and foreign competition; nowhere is competition keener than in the high-production automotive industry. A panel of top-flight automotive executives will discuss designing a product to meet this continuing competition. They will highlight the interplay of production, purchasing, and engineering by prepared discussion and answers to questions from conference participants.

How a Car is Planned and Engineered with Marketing, Purchasing, Manufacturing and Quality-Control Considerations

Will Scott, Executive Director of Central Product Planning Office, Ford Motor Car Co., Dearborn, Mich.

Designing for Function and Cost Objectives

Herbert M. Bevans, Executive Engineer—Chassis, Electrical, Truck Section, Engineering Div., Chrysler Corp., Detroit

Production Engineering as it Effects Car Design and Sales

Conrad F. Orloff, Assistant Chief Engineer, Production Engineering Dept., Chevrolet Motors Div., General Motors Corp., Detroit

Role of the Supplier in Meeting Competition

Carl E. Burke, Chief Development Engineer, American Motors Corp., Detroit

Tuesday, 9:30 a.m.

Manufacturing—Key to Saving

Two key considerations that can reduce manufacturing costs are producibility of a product and material standardization. Significant manufacturing techniques that make a product "producible" and savings that can be derived from a material standardization program will be discussed.

Producibility—Designing for Production

C. Edward Warner, Manager—Advanced Manufacturing Engineering Service, and Robert L. Berg, Consultant—Producibility Engineering, General Electric Co., Schenectady, N. Y.

Material Standardization to Reduce Costs

Gerald L. Swartwood, Material Engineer and Drafting Supervisor, The Bryant Electric Co., Bridgeport, Conn.

Automatic Equipment—Speeds Production

Modern machines use hydraulic power and special drives formerly thought impractical. Two papers outline the analysis of system dynamics and the matching of components in high-speed, high-production, automated equipment.

Special Requirements of Hydraulic Circuits for Servo Controlled Machinery

Robert K. Sedgwick, Assistant Chief Engineer, Servo Div., Kearney and Trecker Corp., Milwaukee

Drives for Tape-Controlled Machine Tools

George W. Younkin, Chief Development Engineer, Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.

Glass and Ceramics—New Design Possibilities

Continuing analysis and testing are giving new insight into physical, chemical, and mechanical properties of these engineering materials. The papers update present information, show newer engineering applications, and compare glass and ceramic with metal.

Ceramic Materials: A Chemical and Structural Description

Marvin G. Britton, Technical Manager, Government Services Dept., Corning Glass Works, Corning, N. Y.

What Do Glasses and Ceramics Offer the Design Engineer?

John R. Blizard, Manager, Product Engineering Dept., Technical Products Div., Corning Glass Works, Corning, N. Y.

High-Strength Steel-Impact of Recent Development

Metallurgical and mechanical aspects of high-temperature, cold-reduced stainless and precipitation-hardenable steels are discussed in two papers. Examples on how to design and fabricate are based on new developments.

High Strength Steels-Part I, Materials

R. A. Lula, Chief Research Metallurgist—Stainless Steel, Allegheny Ludlum Steel Co., Pittsburgh

High Strength Steels—Part II, Design and Fabrication

Richard H. Marvin, Chief Engineer, SpaceAtomics Section, Product Development Dept., The Budd Co., Philadelphia

Wednesday, 9:30 a.m.

Motors—Economics and Applications

The high-temperature motor is an original equipment item that can offer real economics through weight and size reductions. Many new applications are offered in the companion paper on synchronous units.

Electric Motors at Higher Temperatures for Industrial Usage

Frank C. Rushing, Engineering Manager, Motor and Gearing Dept., Westinghouse Electric Corp., Buffalo

Mechanical Application of Nonexcited Synchronous Motors

J. P. Landis, Development Project Engineer, Electromechanical Development Section, Mechanical Development Laboratory, E. I. du Pont de Nemours & Co., Wilmington, Del.

Production—Cost Saving Hints

Numerically controlled machines require special part design to effect the greatest saving. At the same time, close tolerances and finishes add cost even though automatic machines can do the job. Charts permit optimum selection of all factors to reduce product cost.

Design Considerations and Drafting Techniques for Production on Numerically Controlled Production Machines

Alexander Taleff, Equipment Development Engineer, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp., Pittsburgh

Cost and Value of Small Tolerances and Smooth Finishes

W. W. Gilbert, Manager, Machining Development Service, Manufacturing Engineering Service, General Electric Co., Schenectady, N. Y.

Adhesives for Metal Bonding

Adhesives are one of the newest methods of bonding metals—bonded engine parts are under test. Factors which must be known for most design problems are given, and the differences between bonding metal parts and nonorganic materials are also discussed.

Elastomeric Adhesives-Industry's New Tool

W. C. O'Leary, Technical Director, Adhesives, Coatings, and Sealers Div., Minnesota Mining and Manufacturing Co., St. Paul

Factors in Joint Design Using Adhesives for Metal Bonding

Kenneth F. Charter, Director, Plastics Research, and Harry R. Butzlaff, Supervisor, Plastics Research, A. O. Smith Corp., Milwaukee

Thursday, 9:30 a.m.

Cost Analysis—Fasteners and Powder Parts

Two papers evaluate the engineering and production problems pertaining to application, function, and design of standard and custom-engineered fastener and powder-metal parts.

Which Fasteners Should We Choose?

John W. Stoutenburg, Vice President, Robin Products Co., Warren, Mich. and Kenneth D. Ringland, Chief Engineer, Central Screw Co., Keene, N. H.

Designing with Powder Metallurgy to Improve Quality and Reduce Cost

Paul J. Failla, General Superintendent—Machine Shops, Johnson Bronze Co., New Castle, Pa.

Plastics-Unusual Behavior

Two papers indicate the influence of basic-material properties on end products: One considers the deceptively simple process of filament winding; the other points out specific areas where design problems are met with unusual types of behavior in plastics.

Filament-Wound Pressure Vessels

Richard Gorcey, Group Leader, Solid Propulsion Structural Components, Rocketdyne, A Div. of North American Aviation Inc., Canoga Park, Calif.

An Introduction to Designing with Plastics

R. L. Thorkildsen, Mechanical Behavior Engineer, General Engineering Laboratory, General Electric Co., Schenectady, N. Y., and John V. Schmitz, Manager-Chemical Research, Major Appliance Chemistry Laboratory, General Electric Co., Louisville, Ky.

Dynamics—Damping and Gears

Two engineering problems occur on all manufactured products where vibration, shock, and misalignment are met. Both papers present new engineering solutions and are of special interest to engineers in the heavy equipment and automotive fields.

Visco-elastic Damping

D. Kent Hatch and \widetilde{C} . Howard Adams, Plastics Div., Monsanto Chemical Co., Springfield, Mass.

Effect of Misalignment on Tooth Action of Bevel and Hypoid Gears

Meriwether L. Baxter Jr., Chief Research Engineer, Gleason Works, Rochester, N. Y.

Lubrication—Molydisulfides as an Answer

New lubrication frontiers are being probed, and these two papers answer many of the questions about what molybdenum disulfide materials can be expected to accomplish. Many misconceptions will be cleared up as laboratory testing, performance, and material evaluations are offered.

Molybdenum Disulfide As a Lubricant

Kenneth B. Wood Jr., Manager, Chemical Div. Climax Molybdenum Co., Div. of American Metal Climax Inc., New York

Molybdenum Disulfide as an Additive to Improve the Performance of an Automotive Multipurpose Grease

H. G. Rudolph Jr., Automotive Div. Products Dept., and C. D. Thayer (Deceased), Socony Mobil Oil Co. Inc., New York



HIBITORS

Open every afternoon and one evening during the Design Show, Detroit's new Cobo Hall will accommodate all exhibitors on one floor.

Hours are noon to 5:30 p.m. May 22, 24, and 25, and noon to 10:00 p.m. May 23 (Tuesday). A registration fee of \$2 is payable at the registration desk in Cobo Hall.

Visitors are invited to stop at MACHINE DESIGN's booth, No. 363.

A	
ACF Electronics Div., ACF Industries	
AFCO Fitting Co., Div. of U. S.	1023
AFCO Fitting Co., Div. of U. S.	
Air Compressor Co	953
Acme Chain Corp	1004
Acme Steel Co	301
Adams & Westlake Co	201
Aeroquip Corp	619
Aetna Ball and Roller Bearing Co	213
Aircraft & Missiles	349
Airmatic Valve Inc	1152
Air-Maze Corp	160
Louis Allis Co	945
Alloy Casting Institute	329
Alloy Products Corp	221
Aluminum Co. of America	721
Aluminum Extrusions Inc	313
Amco Engineering Co	449
American Machine & Metals Inc	857
American Nickeloid Co	1042
American Optical Co	1139
American Screw Co	835
American Sealants Co	131
American Smelting & Refining Co	711
American Society of Mechanical	
Engineers	1253
American-Standard, Controls Div	257
American Stock Gear Div., Perfection	-01
Gear Co	1212
American Zinc Institute	712
Amplex Div., Chrysler Corp	1142
Anaconda Metal Hose Div., American	~~~
Brass Co	312
Anderson Co., Roton Products Div	800
Arch Instrument Co. Inc.	1011
Arguto Oilless Bearing Co	210
Armco Steel Corp	409
Associated Spring Corp	445
Atlas Chain & Mfg. Co	505
Auburn Mfg. Co.	540
Automatic Switch Co	825
Automation	363
ZIBEUMBUR	-90

Automotive Rubber Co. Inc	932
Adhesive Products Inc	905
AviSun Corp	219
В	
market Brown Brown A	
B-Mold Div., Buckeye Brass &	1032
Barry Controls Inc	904
Battelle Memorial Institute	236
Beaver Precision Products Inc	410
Bendix Computer Div., Bendix Corp.	1147
Bendix Foundries Div., Bendix Corp.	1147
Beryllium Corp	520
Binks Mfg. Co	519
Boston Gear Works	342
W. H. Brady Co	321
Bristol Co	1036
Brook Motor Corp	1121
Browning Mfg. Co	251
Brush Beryllium Co	657
Buchanan Electrical Products Corp	720
Burling Instrument Co. Inc	124
c	
Cadillac Plastic Co	207
Carr Fastener Co., Div. of United-	145
Carr Fastener Corp	1242
Carter Controls Inc	1005
Casting Engineers Div., Consolidated	2000
Foundries and Mfg. Corp	460
Celanese Plastics Co., Div. of Celanese	
Corp. of America	645
Century Electric Co	921
Chain Belt Co	929
Chart-Pak Inc.	458

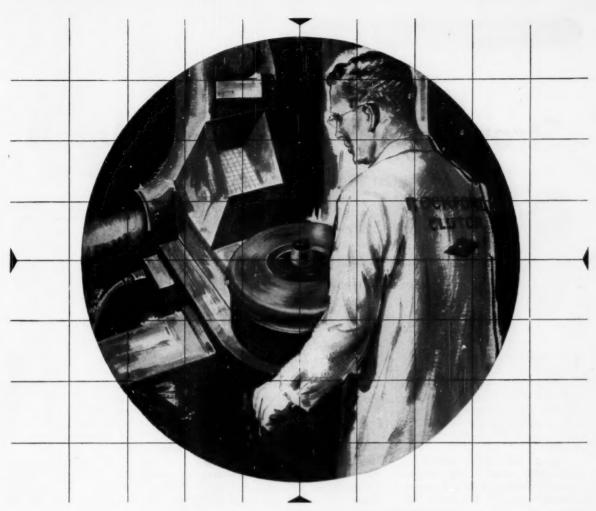
Chemiquip Co	1200
Chemo Products Inc	332
Cherry Electrical Products Corp	1118
Chicago-Allis Mfg. Corp	154
Chicago Rivet and Machine Co	1218
Chilton Co	349
Circle F Mfg. Co	422
Clad-Rex Div., Simoniz Co	309
Cleveland Graphite Bronze Div.,	
Clevite Corp	121
Cleveland Machine Controls Corp	336
Climax Molybdenum Co., Div. of	
American Metal Climax Co	511
Clippard Instrument Laboratory Inc.	1013
Coating Products Inc	938
Cobehn Inc.	102
Colonial Rubber Co	919
Columbus Coated Fabrics Corp	525
Columbus Electric Mfg. Co	1055
Combination Pump Valve Co	805
Commercial Filters Corp	214
Congress Drives Div., Tann Corp	924
Conneaut Rubber & Plastics Co	919
Continental-Diamond Fibre Corp	156
Controlex Corp. of America	122
Coors Porcelain Co	1262
Copper & Brass Research Association	528
Corbin Cabinet Lock Div., American	-
Hardware Corp	1223
Crane Packing Co	237
Crawford Fitting Co	1108
Cullman Wheel Co	1144
Curtiss-Wright Corp., Marquette Div.	1219
Cycledynamics Inc.	1206
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D. S. D. Mfg. Co	222
Dayton Industrial Products Co., Div.	
of Dayco Corp	1017
Decatur Casting Co	955
De Laval Steam Turbine Co	836

Deliuxe Coils Inc. Delison Engineering Div. American Brake Shoe Co. 611 Design News 75 Design News 75 Detroit Controls Div. American Radiator & Standard Sanitary Corp. 25 Disongrin Industries 123 Dixon Corp. 144 Dixon Sintaloy Inc. 105 Dobeckmun Co. Div. of Dow Chemical Co. 105 Dobeckmun Co. Div. of Dow Chemical Co. 105 Dobeckmun Co. Div. of Dow Chemical Co. 106 Doy Chemical Co. 107 Dow Corning Corp. 644 Drop Forging Association 106 Doy Chemical Co. 107 Dixon Corp. 108 Dixon Corp. 108 Dixon Corp. 108 Dixon Corp. 108 Dixon Corp. 109 Di
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Strength of Refractory Metals

at high temperatures

AL DONLEVY and JACK K. Y. HUM

Research Metallurgists, Stauffer Metals Co., Richmond, Calif.

I N THE quest for materials for very-high-temperature service—2400 to 5000 F—only four metals and their alloys show promise: Columbium, molybdenum, tantalum, and tungsten. There are a few other suitable metals, but supply is limited.

Design information needed to apply these metals at high temperatures is obtained mainly by stress-rupture testing. Properties obtained are: Per cent elongation, mode of fracture, and time to failure. In the past, the use of these metals at high temperatures has been hindered by scarcity of corresponding design data. There are

practically no data for temperatures of 3000 F and higher. Now, however, these temperatures are reached easily by electron-beam heating. That technique was used to obtain the values reported here.

Materials: With the exception of tungsten wire, all the metals and alloys under test were electron-beam melted, forged into sheet bar, conditioned, annealed, and rolled into sheet.

1. Scb 278 is a columbium-tantalum-molybdenum alloy of good fabricability and ductility. A 10 lb sample was melted into 13/4 in. diameter ingot. The ingot was forged into a sheet bar 2 in. wide $x \, {}^5/\!\!/_8$ in. thick $x \, 16$ in. long. The bar was then conditioned and annealed in a vacuum for 2 hr at 2000 F. The sheet bar was then warm rolled at 500 F until it was ${}^1/\!\!/_4$ in. thick. Test specimens were cut from the sheet.

2. Scb 291 is a columbium-tantalum-tungsten alloy of good fabricability and ductility. Similar procedure as described for Scb 278 was repeated for Scb 291.

3. The 90 Ta, 10 W alloy is composed of 90 W/O tantalum and 10 W/O tungsten. Samples were prepared from an ingot 5 in. in diameter. The ingot was forged into a

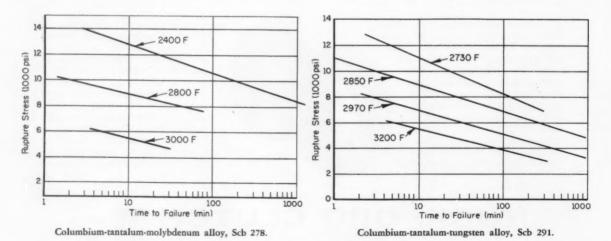


Fig. 1—Properties of columbium alloys.



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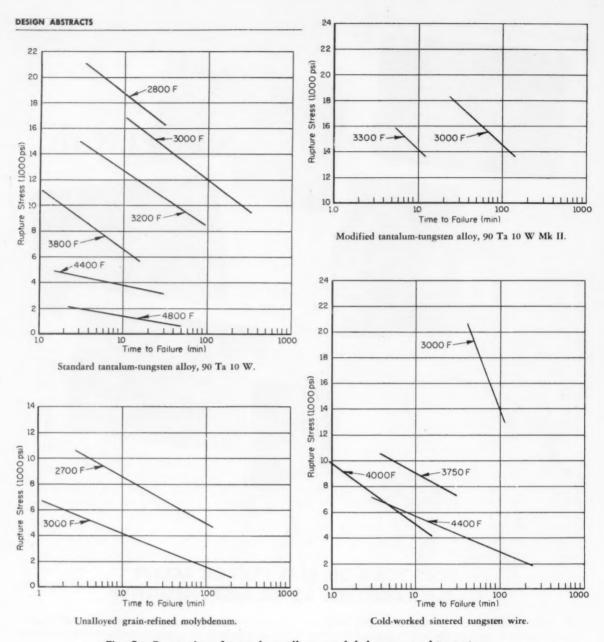


Fig. 2—Properties of tantalum alloys, molybdenum, and tungsten.

number of sheet bars 4 in. wide x 1 in. x 14 in. long. The plate was conditioned and vacuum annealed by electron-beam annealing at 2700 F for 30 minutes. The annealed plate was warm-rolled at 500 F to half thickness, annealed again, and rolled to 0.050-0.060 in. thick sheet from which the specimens were cut.

4. The 90-10 Mk II alloy is a modification of the standard 90-tantalum, 10-tungsten alloy. It has additional amounts of molybdenum and zirconium added for addition-

al high temperature strengths. Identical procedures were used on 90-10 Mk II as on the 90-tantalum, 10-tungsten alloy.

5. The grain refined molybdenum came from a 6 in. diameter ingot. After surface conditioning, the casting was forged into a sheet bar. The 1 in. thick sheet bar is conditioned and hot rolled into ½ in. plate. After conditioning the plate is annealed at 2100 F and rolled to sheet 0.060 in. thick.

6. Because of time limitations, it

was not possible to use electronbeam melted tungsten sheet. Therefore, 0.070 in. diameter coldworked sintered tungsten wire was used as stress-rupture test specimens.

Test Procedure: In all cases, the test specimens were placed between water-cooled grips and aligned carefully to avoid any stresses other than uniaxial. The test chamber was then closed and evacuated to 0.1-0.01 micron vacuum. Electron



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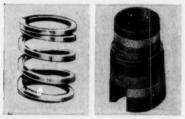


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beam heating was used as the best heat source.

Unlike conventional heating, where a large amount of energy is wasted on heating the surroundings, electron-beam heating is concentrated on the test specimen. tungsten filament is heated to an elevated temperature to insure a good source of electrons. A high, direct-current potential is placed between the filament and specimen with polarity in such a manner that electrons are drawn to the specimen. The specimen is heated by the bombardment of electrons, hence the term "electron-bombard-ment heating." The beam bombards a section of the test specimen roughly three inches in length. Since the electron gun is annular, the specimen is bombarded from 360 deg so that heating is peripheral and uniform.

There are two minor drawbacks to the use of this method: 1. The work must be done in high vacuum. 2. The lowest test temperature is 2200 F at the present time. Advantages of this method are numerous: There are no limits to high temperature, power requirements are low, the system is compact, heating is rapid, and the system is stable.

In these tests, voltage was gradually increased until the specimen reached 1600 to 1900 F. It remained at this temperature for a few minutes to permit any outgassing. The high voltage was then increased until the desired temperature was reached. Then the load was applied to the specimen. The total time required for the procedure averages about 15 minutes.

Results: Test observations for the different metals and alloys are plotted in Fig. 1 and 2. It can be seen that results are fairly consistent. Tests over 16-hr periods indicate that the unit is extremely stable.

There may be questions regarding the elapsed times of tests. Present-day requirements for refractory metals have been for missile applications where the life of material is very short. To date, the data required in stress-rupture work calls for information on from 1 to 30 minutes duration at elevated temperatures.

Generally, stress - rupture life under 10 minutes produces transcrystalline type of failure while longer periods produces intergranular type of failure.

SAE Paper No. 354D, "Some Stress Rupture Properties of Columbium, Molybdeum, Tantalum, and Tungsten Metals and Alloys between 2400 and 5000 F," presented at the SAE National Aeronautic Meeting, New York, April, 1961, 6 pp.

mechanical

Critical Design of Gear Roots and Fillets

Ben F. Bregi, National Broach & Machine Co.

The critical nature of gear-tooth root and fillet design. If the fillets in a gear are too high on the gear profile, the mating gear can contact the fillet and cause excessive wear and noise. On gears with small numbers of teeth, normal generated fillet undercut can remove active contact between gears. This may weaken the tooth and can cause excessive load and noise conditions. Similarly, too much undercut made by protuberance-type tools, or too small a fillet can weaken the gear teeth.

A properly designed gear fillet will take into account the strength of the gear, the actual shape of the fillet as produced by the specific tooth production process, the amount of involute profile needed for proper meshing with the mating gear, and the provision of sufficient clearance for the finishing tool. If any of these considerations are overlooked, the Achilles-heel effect of the fillet can cause excessive manufacturing tool costs, poor gear quality, and possible gear failure.

SAE Paper No. 333A, "Roots and Fillets—The Achilles Heel of Gear Design," presented at the 1961 SAE National Automobile Week, Detroit, March, 1961, 5 pp.

Fuel Cells— Present and Future

H. H. Chambers, Sondes Place Research Institute, Dorking, Surrey, England

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Since these first cells will not be capable of rapid start-up, they are unlikely to be used to drive automobiles. They will be quite suitable for any use where the power demand is steady or intermittent but without long idle periods. The first commercial batteries are likely to replace small motor generator sets of up to 20 kw output.

Parallel development of other types of cells, including low-temperature cells, is probable and such cells will be used for special purposes where their relatively high cost can be tolerated.

"Fuel Cells," presented at a general meeting of the North-East Coast Institution of Engineers and Shipbuilders (Great Britain), March, 1961, 12 pp.

External Expansion and Residual Stresses in Pressure Cylinders

G. J. Franklin, lecturer, Mechanical Engineering Dept., University of Nottingham, and J. L. M. Morrison, professor of mechanical engineering, University of Bristol, England

Shear stress-strain relationship for an initially stress-free 2½ per cent nickel-chromium-molybdenum steel under reversed stress. The effect of a low-temperature heat treatment given to this material after various amounts of overstrain is determined similarly.

Information so obtained is used to calculate the behavior of thick cylinders subjected to one or two cycles of internal pressure, with or without an intervening low-temperature heat treatment.

Such cylinders have been made and subjected to the treatment described. Pressure and dimensional changes have been measured at all stages. The cylinders have been bored out in steps until all the overstrained material has been removed,

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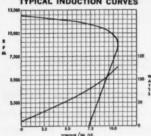
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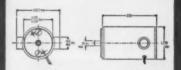
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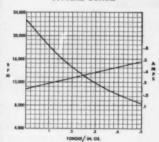
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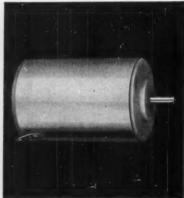
If you face a DC motor application problem let a Motordyne field engineer assist in the solution. For prompt attention contact either the East or West Coast facilities.



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369 BAYVIEW AVENUE AMITYVILLE, L. I., N. Y. Barber-Colman quality battery-operated d-c motors with integral governors ideal for many of today's portable applications





BYQM-Typical Specifications Voltage range approx. 3 to 30 Governed speed approx. 1200 to 6000 rpm Torque 0 to .20 oz-in. Maximum dia 1.29





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d-c small motors

TYPE BYQM, above left, is inexpensive, yet of excellent quality to meet consumer demand for dependability in mass-produced goods. Its high efficiency results in low current drain, longer battery life. Integral governor features exceptionally stable characteristics. Rugged, self-aligning bearings.

TYPE HYQM, above right, is an exceptionally fine-quality battery-operated motor for the more demanding applications such as certain portable instruments and marine navigation equipment. Integral governor has adjustable stationary contact. Square brushes with optimum pressure over entire useful life. Self-aligning sintered bronze or R1 ball bearings. Ambient temperature maximum, 200° F.

WRITE FOR HELPFUL DATA SHEETS on BYQM and HYQM battery-operated motors specifically designed to fit individual customer applications.

the corresponding dimensional changes being again measured. It is shown that both the dimensional changes and the shear stress distribution at any stage in the process can be calculated with satisfactory accuracy by relatively simple approximate methods.

IME Paper No. 32/60, "Autofrettage of Cylinders; Prediction of Pressure/External Expansion Curves and Calculation of Residual Stresse," to be published after May 31, 1961, 21 pp.

Lightweight Diesel Engine

L. Wechsler, Bureau of Ships, Navy Dept., L. Thompson and E. Tsakiris, Utica Div., Curtiss-Wright Corp.

Design evolution and basic features of a new 900-hp lightweight, heavy-duty diesel engine. Discussions show how early field experience in lightweight diesel engines guided special engineering studies, which eventually established important features of the new engine. Included are technical data regarding certain design parameters important in lightweight engine construction plus performance data of the 900-hp engine. Major design investigations were conducted for the combustion system, connecting rods and crankshaft, and the four-cycle valve train and crankshaft.

ASME Paper No. 61-OGP-5, "Evolution and Development of a 900-hp Marine Diesel Featuring Ruggedness and Serviceability in a 4½ lb/hp Package," presented at the Oil and Gas Power Conference and Exhibit, New Orleans, April, 1961, 11 pp.

processes

Evaluating Arc Spot Welding

B. L. Kosnik, Chrysler Corp., Detroit

Aspects of design to be considered in the evaluation of arc spot welding. Correct design for this type of welding takes into consideration such factors as type of joint to be specified, material thickness combinations, accessibility for welding torches and other related equipment, and the location of welds. When selecting a suitable welding process for a given design, it is necessary to take into account such items as cost, appearance requirements, permissible weld-quality deviations, ef-

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fects of weld spatter, and weld strength.

Advantages that this process presents to the design engineer are:

- Less material will be used by eliminating or decreasing welding flanges.
- Composite assemblies can be designed using expensive materials only in areas where they are required.
- Distortion and warping is easily controlled.
- Machining and heat-treating operations can be simplified by proper design and processing.
- The number of components required to form an assembly usually can be decreased by welding.
- Individual part designs can be simplified.
- Manual assembly and adjusting operations can be eliminated or simplified.
- Welding can be accomplished in blind sections without the use of pressure or backup.

SAE Paper No. 329C, "Arc Spot Welding in Automotive Production," presented at the 1961 SAE National Automobile Week, Detroit, March, 1961, 5 pp.

hydraulic

Analysis of Torque Losses in Flat-Faced Gasketed Joints

E. M. Smoley and F. J. Kessler, Armstrong Cork Co.

Basic factors or variables which affect torque losses in a flat-faced gasketed joint design.

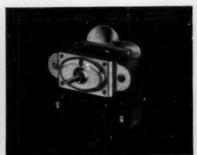
Long bolts, because of their elongation, will reduce torque losses, but not until the proper compression loads have been achieved on the gasket. These critical gasket loads have been defined in the current gasket literature.

Flange-bolt combinations made from dissimilar metals — for instance, steel bolts and aluminum flanges—will tighten when heated and loosen when cooled. These are thermomechanical effects which are roughly proportional to the thickness of the aluminum flange.

Due to the nonmetallic nature of gasketing materials, torque losses increase with time as measured, since the flanged assembly was initially clamped-up. But at any given temperature, the loss appears not to increase indefinitely with time, but to reach some equilibrium value

Synchronous shaded pole a-c motors by Barber-Colman for applications requiring precise timing and high pull-out torque...











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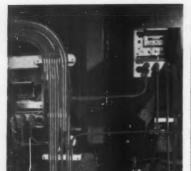
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Developing 30 times the power of ordinary timing motors, Barber-Colman synchronous motors economically provide the dependability and long life necessary to many precision applications . . . such as X-ray timers, chart drives, scoreboard timers, oscillographs, facsimile recorders and many other industrial and scientific instruments. They synchronize rapidly and their high pull-out torque provides a reserve of power to maintain smooth operation during sudden load changes or fluctuations in supply voltage. Write for Bulletins M-5 and G-1.

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which is attained shortly after the initial tightening of the joint assembly. Equilibrium values, or equilibrium torques retained, as they are referred to here, are in themselves dependent upon temperature. They decrease as the temperature increases. Reducing the uncompressed thickness of a gasket produces better torque retention.

Torque losses vary with gasket compositions. Comparisons are made among various gaskets containing asbestos fibers, cellulose fiber, and cork and rubber.

SAE Paper No. 324B, "An Analysis of Torque Losses in Flat-Faced Gasketed Joint Designs," presented at the 1961 SAE National Automobile Week, Detroit, March, 1961, 10 pp.

Blade Profiles for Axial-Flow Fluid Drives

A. D. S. Carter, professor of mechanical engineering, Dept. of Civil and Mechanical Engineering, Royal Military College of Science, Shrivenham, England

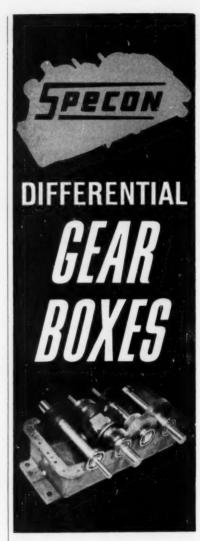
Basic factors controlling blade-section performance. Substantial differences in performance may be expected from profiles having different fluid surface-velocity distributions. Desired velocity distribution may be achieved by appropriate selection and combination of relevant physical parameters. Two examples show how. One is marked improvement obtained in the off-design performance of a high-duty subsonic multi-stage compressor. The second is marked advance made in the transonic compressor stage.

IME Paper No. 34/60, "Blade Profiles for Axial-Flow Fans, Pumps, Compressors, Etc.," to be published after May 31, 1961, 16 pp.

Thick-Walled Cylinders Under High Pressure and Temperature

A. E. Johnson, J. Henderson, and B. Khan, Materials Division, National Engineering Laboratory, East Kilbride, England

Analysis of the stresses and strains in a thick-walled cylinder, under internal and external pressure. In practice, cylindrical pressure vessels or thick-walled tubes may be subject, at elevated temperatures, to internal and external pressures in



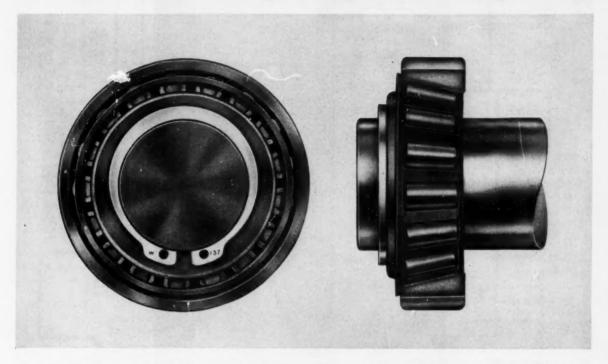
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and other bulkier and more expensive fastening devices normally required for extreme loading conditions. The Truarc Series 5160 is available in 11 popular sizes for shafts ranging from .473" to 2.0" dia. — and other sizes are on the way. You can order the Series 5160 in carbon spring steel or — for corrosion resistance and high temperature limits — in Armco PH 15-7 Mo stainless steel. Sizes up to 1.378" also are available in beryllium copper. For complete specifications, write for Truarc Data Bulletin No. 459-11. Better yet, contact your local Truarc Representative or Distributor. They're listed in the Classified Telephone Directory under "Retaining Rings" or "Rings, Retaining."

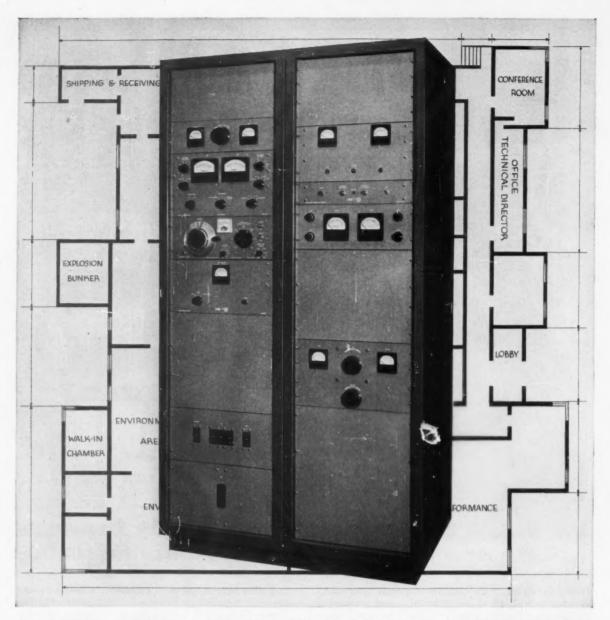
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The Ling Model A-175, electrodynamic shaker pictured above, a typical shaker used with the Model RP 5/6 Sine-O-Matic System, delivers 1500 pounds force for sine wave testing.



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such circumstances that creep strains and elastic strains are both of significant order. Accordingly, it is obviously of practical importance that an analysis be made of the changes of distribution of stress and strain with time.

In the first portion of the paper, theoretical relations between stress, strain, and time are derived. In the second portion, the application of these relations to a number of metallic alloys at temperatures within their practical working ranges is examined.

IME Paper No. 38/60. "Behaviour of Metallic Thick-Walled Cylindrical Vessels or Tubes Subject to High Internal or External Pressures at Elevated Temperatures." to be published after May 31, 1961, 29 pp.

materials

Bonding Structural Adhesives

E. J. Sydor, Cycleweld Chemical Products Div., Chrysler Corp.

A review of the more prominent types of structural adhesives and bonding methods, and indications where advances can be made in the immediate future.

The use of structural adhesives will continue to grow because of certain well-defined advantages over the other joining methods. Not only does the structural adhesive join the two pieces, but it also provides a continuous seal between them, giving a certain measure of vibration dampening. The continuous seal of a nonconductive material practically eliminates the possibility of bimetallic corrosion. The joints formed are smooth and protrusion free, and in certain materials such as glass or aluminum, bonding can be readily accomplished where it is difficult or impossible with other methods. Further, the load is distributed over the entire bonded area, permitting the designer to use thinner sections and providing superior fatigue resistance.

It should be emphasized that adhesive bonding at the present time has certain limitations. For many of these adhesives, it is essential that there be a controlled application of heat and pressure for a specified period of time. All of them have limited temperature stability and durability under severe environmental conditions. However, the

practicality of the system has been effectively demonstrated in many applications.

SAE Paper No. 330B, "Bonding of Structural Adhesives," presented at the 1961 SAE National Automobile Week, Detroit, March, 1961, 5 pp.

Plain Bearing Materials At Low Temperatures

R. Hargreaves and D. H. Tantam, Scientific Div., British Oxygen Co., Ltd., London, England

Results of wear tests made on journal bearings for use at liquid oxygen and liquid nitrogen temperatures, -183 C and -196 C, and the design of large bearings for use at these temperatures.

The problem of operating plain bearings at low temperatures is largely the selection of materials. Tensile strength, compressive strength, and associated properties of materials increase to a greater or less degree as the temperature falls. At the same time, the impact strength may increase, decrease, or vary little with falling temperature.

Generally, nickel, copper, aluminum, and their alloys, together with austenitic stainless steels, show no lowering of impact properties as temperature falls.

Coefficient of expansion and thermal conductivity are important in plain dry-lubricated bearings, no matter what the temperature of operation. In some ways, a cold environment is favorable to the operation of bearings because greater heat dissipation is possible. Cooling by passage of the cold environment fluid through the bearing can be arranged. Also, it is not necessary to resort to a high-strength non-metallic reinforcing matrix of excessive hardness in the bushing.

IME Paper No. 31/60, "Performance of Some Plain Bearing Materials Under Boundary Conditions at Low Temperatures," to be published after May 31, 1961, 11 pp.

Tensile Properties of Two Stainless Steels in a Range of Section Sizes

W. H. Pryle and E. T. Wessel, Westinghouse Research Laboratories

Tensile properties of AISI types 304 and 347 annealed stainless steels in



the temperature range from 75 to 800 F. Several lots of materials were studied in each of several section sizes ranging from bar stock to extremely large forgings.

Conclusions are:

- A substantial variation in tensile properties, particularly yield strength and elongation, prevails between different lots of either AISI type 304 or 347 annealed stainless steel.
- The variation in tensile properties correlates with variations in the asannealed hardness.
- The prime source of these variations is attributed to differences in annealing treatments.
- 4. In order to obtain reasonably consistent properties from one lot of a given type of steel to another, it would appear necessary to specify the annealing treatment and/or the annealed hardness.
- An appreciable strength advantage, without a serious loss of ductility, could be realized by utilizing the higher hardness levels.
- In general, the properties of large forgings are comparable to those obtained in bar stock.
- The ductility of large forgings in the direction transverse (perpendicular) to the primary working direction is considerably poorer than the longitudinal direction.
- The relatively poor transverse ductility of large forgings does not lead to problems of notched sensitivity of embrittlement in the temperature range of interest (0 to 800 F).

ASME Paper No. 60-WA-9, "Tensile Properties of AISI Types 304 and 347 Stainless Steels at Moderate Temperatures for Section Sizes Ranging from Bars to Extremely Large Forgings," presented at the Winter Annual Meeting, New York, November-December, 1960, 10 pp.

Effect of Cracks on Brittle Fracture Strength of Steel

S. Yukawa, Materials and Processes Laboratory, Large Steam Turbine Generator Dept., General Electric Co., Schenectady, and J. G. McMullin, Research Laboratory, Crucible Steel Co.

Effects of various methods of notch preparation on the notched slow-bend fracture strengths of heat-treated alloy steel specimens. Test results indicate that arrested cleavage or fatigue cracks lower the brittle fracture strength by about 35 per cent compared to a machined notch with approximately 0.005 in. radius. This difference is observed if the



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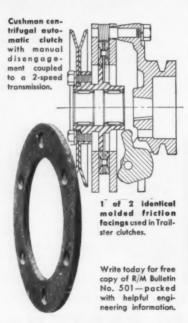
R/M found friction material answers for versatile Cushman Trailster

"We placed our friction problems for the Trailster's centrifugal automatic clutch in Raybestos-Manhattan's hands," says R. D. Von Seggern, assistant chief engineer, Cushman Motors, Lincoln, Nebr.

"Cushman has been using Raybestos-Manhattan friction materials in various models of utility vehicles for over 15 years. Based on past experience, we know we can rely on them for assistance at every stage -from design to production.

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Why not take a tip from Mr. Von Seggern-call on us and make use of our knowledge of friction accumulated from 50 years of experience. Just phone or write-a sales engineer can be at your desk within 24 hours. Remember . . . only R/M makes all types of friction materials; your assurance of unbiased council.



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specimen size is sufficiently large. With decreasing size, the difference becomes less and may disappear altogether if relatively small specimens are tested. By nitriding the notch, it appears possible to obtain effects with machined radius notches equivalent to cracks.

ASME Paper No. 61-Met-2, "Effects of Specimen Size and Notch Acuity on the Brittle Fracture Strength of a Heat-Treated Steel," presented at the Metal Engineering Conference, April, 1961, 4 pp.

techniques

Four-Pole Parameters Of Complex Structures

F. B. Safford, supervisor, Weights and Mechanical Analysis, Nortronics Div. of Northrop Corp.

A method of measurement of the four pole parameters of a system as a function of frequency. This procedure consists of no-load dynamic measurements followed by measurements under a known load. From the foregoing measurements, the four pole parameters of a system are derived. Application is made to an electrodynamic motion exciter with graphical presentation of the parameters with respect to amplitude, phase angle and real and imaginary

ASME Paper No. 61-Av-7, "Measure-ment of Four Pole Parameters of Com-plex Structures," presented at the Avia-tion Conference, Los Angeles, March,

Predictive Control Systems-**Advantages and Applications**

. Chestnut, W. E. Sollecito, and H. Troutman, General Electric Co., Schenectady

Potential design uses of predictive control-a form of automatic control in which the manipulated variable operating the controlled system is actuated by an estimate of the error which will exist at some future time. Repeated estimations of the future error are obtained by predicting ahead on a fast-time base both the reference and the controlled variable as well as some of their lower-order derivatives. Data smoothing and prediction of the reference may be required, and use of a model of the controlled system is needed.

Use of predictive control appears

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With apologies to Tennessee Williams, we really have produced a Solenoid Valve line based on your desires. We surveyed all the solenoid valve users we could find to determine what you wanted. The result is Hoke's "User Designed" Series 90 and 95, two-way and three-way, direct-acting solenoid valve line.

Thanks to you, we have much to brag about. Here's what we have been saying about these new valves: lightest weight – smallest size – no-hum operation – lowest temperature rise – lowest power consumption – stainless steel plunger – silver AC shading coils – easiest installation – packless construction – 360° rotatable housing – operates in any position.

We make them of forged brass or stainless steel, in 1/4" and 1/4" NPT size or JIC tube ends. There's a variety of AC and DC voltages. Class "A" coils are standard, but Class "H" are also available for temperatures above 212°F. For those

peratures above 212°F. For those with high insurance rates, we can supply explosion proof coil housings.

Now that we've bragged a bit, we must also apologize for our premature enthusiasm. We were so excited about this product that we stirred up a hornet's nest of interest before we were ready to deliver in quantity. Shipments were slow at the start, but now we can have any reasonable quantity of these "desirable" solenoid valves "on-stream" in your plant when you want them.

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Further flow features, and interesting technical topics are carefully covered in Hoke's technical publication, the FLOW SHEET. It's free, but worth millions! To get the full benefit of our engineering and editorial efforts six times a year, mark your "X" in the proper box.

The technique of molding polyvinyl chloride into ball valve parts is old hat. Even the unplasticized compounds of type I PVC have been kicked around for a while (with minor successes). But until now, no one has booted the ball for a goal.

Perseverance, determination, and the pursuit of economic reward have prompted us to offer a line of ball valves molded of the toughest grade of type I, unplasticized PVC. There are no foreign agents to

contribute to a corrosive demise, even in most caustic services. It even meets the proposed new ASTM specification and has a tensile strength of 8500 psi. Those who have had PVC piping problems will profit from the new molding process that gives these Hokes dimensional stability and very high impact strength. Sensitive systems, human and otherwise, are safe from contamination—they're absolutely non-toxic. We've set 140°F. as the operating temperature limit, but occasional excursions to 160°F. won't do any harm.

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You will command the eternal admiration of your colleagues when you install these valves. Be the first to show your rightful status by ordering a shiny new Hoke polyvinyl chloride ball valve. If pride of ownership hasn't motivated you at this point, the mere fact that you are behind the scientific times should move you to find out more.

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Pressure: to 540 psi.

Ten orifice sizes: 3/4" through 1/4".

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Circle 343 on Page 19

DESIGN ABSTRACTS

highly attractive with the availability of small, high-speed logic devices and power-actuating means. With predictive control, any disturbances or reference input value, whether large or small, can bring to bear the full power capability of the power element. As such, with deterministic inputs, faster speeds of response for a given input and power source can be obtained than for a linear system.

By virtue of the repetitive prediction calculations, including in the model the major non-linearities or time variations of the process if necessary, higher gain can be obtained with adequate stability than would be possible with linear means. The equivalent speed of response of the system is markedly dependent on the speed of the repetitive predictions as well as on the ability of system to sense its own performance including its derivatives.

AIEE Paper No. 61-12, "Predictive Control System Application," presented at the AIEE Winter General Meeting, New York, Jan.-Feb., 1961, 9 pp.

Predicting Effects Of Torsional Vibration

C. T. Molloy, member of the technical staff, Space Technology Laboratories

Application of the method of fourpole parameters to torsional vibrations. The four-pole parameters are derived for basic rotational elements which include shafts (both lumped and distributed-parameter cases), disks, dampers, and gears. The equations which must be obeyed, when these elements are connected, are presented.

The application to construction of equivalent electrical circuits is given and, in particular, a method for constructing the equivalent circuit of distributed-parameter systems is put forth. Torsional analogs are given for rotational sources.

Fundamentals of four-pole technique are applied to the following problems: 1. The effect of substituting one four-pole for another in a torsional system. 2. The effect of opening a four-pole system and inserting a new four-pole between the separated four poles. 3. Calculation of all the torques and angular velocities in a tandem system. 4. Calcula-

A RELIABLE PLUG-IN 25 AMP RELAY



More compact than most 10 amp relays

With "Diamond H" Series W dpdt relays you can fit as many as fourteen 25-amp circuits into a space measuring only 1½" x 1½" x 1½"!

Easy to install or remove—Spade terminals for socket or quick-disconnect installation. Solder terminals available.

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CONTACTS:

Arrangement—dpdt, double break, double make. Other arrangements and sequences.

Load—25 amp resistive, 120 or 240 V a-c 25 amp ind., 120 V a-c (75% p.f.) 12½ amp ind., 240 V a-c (75% p.f.) 1 hp 120 V a-c, 2 hp 240 V a-c 25 amp resistive 28 V d-c

MOUNTING: Panel, side or socket DIMENSIONS: $1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{2}$ inches. U/L File 31481

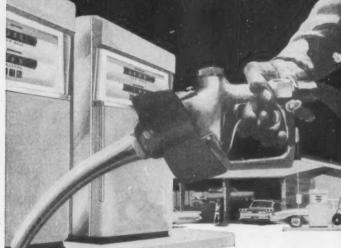
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PREVIEW

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in cooperation horoughly Life-Tested and

tion of natural frequencies of undamped four-pole systems.

ASME Paper No. 61-Av-8, "Applica-tion of Four-Pole Parameters to Tor-sional Vibration Problems," presented at the Aviation Conference, Los Angeles, March, 1961, 20 pp.

Patterns of Failure In Instrument Assemblies

R. L. Horn, chief of the reliability unit, Wichita Div., Boeing Airplane Co.

Generalized analyses of failures based on failure patterns on the B52 airplane. This information indicates that most failures are caused by infrequently failing parts. The impact of this fact on the standard practices of design and procurement of equipment is suggested. Implications of the changing failure rate within a mission are discussed and explanations are offered. Results of analyses directed towards determining the actual number of failures caused by maintenance are included.

ASME Paper No. 61-Av-15, "Patterns of Failures on Guidance and Instrumentation Equipment," presented at the Aviation Conference, Los Angeles, March, 1961,

Vibrations Analysis And Interpretation

D. L. Bernhard, International Research and Development Corp.

Vibration analysis as a tool of engineering diagnosis. Vibration is caused by tolerances resulting in unbalance, misalignment, eccentricity, looseness or excessive clearance between mating parts, and other minor imperfections. These imperfections, which are bound to appear in some degree in every machine, mean a small amount of vibration is to be expected. When imperfections turn into trouble, the vibration becomes significant.

Another important factor about vibration is that its characteristics of amplitude, frequency, and phase are different for each cause. That is, vibration caused by unbalance is different from that caused by misalignment, looseness, and bad bearings. Since more than one troublesome cause of vibration is likely, the vibration of most machines is complex. That is, several frequencies are present, each with a different amplitude and phase.

Analysis of vibration by separating and measuring the amplitude and phase of each frequency shows which part of a machine is causing the vibration and, in most cases,

SAE Paper No. 331B, "Vibration-A New Measurement for Industry," presented at the 1961 SAE National Automobile Week, Detroit, March, 1961, 6 pp.

Random Vibration Testing

Wayne Tustin, manager, Field Service and Technical Training, MB Electronics

Origin and aims of sinusoidal-vibration testing, and the state-of-the-art of random-vibration testing. The most recent developments in automatic testing are described, and a suggestion is made for improved simulation of flight vibration of missiles and rockets.

Vibration testing is one of the most important areas of environmental testing-the simulation of conditions under which equipment must operate. Sinusoidal vibration is described by a review of pertinent history, nomenclature, and testing specifications. For components of modern aircraft, missiles, and rockets, random vibration testing is often required. Present and possible future specifications and testing equipment are discussed.

ASME Paper No. 61-Av-12, "Automation in Random Vibration Testing," presented at the Aviation Conference, Los Angeles, March, 1961, 8 pp.

bearings

A Centrifugal-Effect **Self-Acting Thrust Bearing**

Lucius Walker and Fletcher Osterle, Carnegie Institute of Technology

A possible way to obtain a load capacity dependent solely upon inertia effects. By proper specification of the radial variation of film thickness in parallel-surface thrust bearings, it is found that centrifugalforce effects can be made to contribute positively to the load capacity even without external pressurization. Thus, a self-acting centrifugal-effect thrust bearing is evolved. The optimum film-thickness variation is found to be of step SPEEDS OF LESS
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. . . detects 1 to 4 different speeds (high and low limits, or single limit on each circuit). Designed for low speed applications of less than 100 rpm. Inquire about SYNPROTEX DIFFERENTIAL unit for low speeds . . . or standard SYNPROTEX speed detectors for speeds from 100 to more than 15,000 rpm.

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ENGINEERED PRODUCTS, INC. 26 W. Monroe Street • Bodford, Ohio Phone: BE 2-4100 DESIGN ABSTRACTS

form for both incompressible and compressible lubricants resulting in extreme constructional simplicity for this new bearing.

ASLE Paper No. 61 AM 5B-3, "A Centrifugal Effect Self-Acting Thrust Bearing," presented at the 16th ASLE Annual Meeting, Philadelphia, April, 1961, 14 pp.

Design and Materials For Solid Bearings

Bernard J. Sexauer, National Bearing Div., American Brake Shoe Co.

Design factors as applied to solid bearings, or bearings other than the roller and ball types. Seven most desirable properties required of a bearing are: Fatigue strength, seizure resistance, embeddability and conformability, compressive strength, corrosion resistance, bondability, and low cost. Initial material selection is based on maximum loads, maximum operating temperatures, fatigue strength, antiseizure properties and conformability and embeddability characteristics. Usually more than one material will meet the requirements of an application. Then, comparative cost of materials becomes significant.

ASLE Paper No. 61 AM 2B-3, "Design Considerations for Solid Bearings," presented at the 16th ASLE Annual Meeting, Philadelphia, April, 1961, 11 pp.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to:

AIEE—American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

ASLE—American Society of Lubrication Engineers, 5 North Wabash Ave., Chicago 2, Ill; papers 50 cents to members, 75 cents to nonmembers.

ASME—American Society of Mechanical Engineers 29 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

IME—The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London S.W. 1, England.

North-East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne, England.

SAE—Society of Automotive Engineers, 485 Lexington Ave., New York 17, N. Y., papers 50 cents to members, 75 cents to nonnembers.

Straits Tin Report

Tin reduces wear—The addition of up to 0.1% tin has a marked effect in eliminating ferrite from the matrix of both gray and nodular irons, producing a wear-resistant fully pearlitic matrix.





Effect of tin on pearlite in microstructure of hypoeutectic cast iron bar, 1,2-in. dia.

The amount of tin added to cast iron sections up to 3 in. thick is not critical. A reasonable excess does not produce any massive cementite or affect mechanical properties.

Organic compounds of tin stabilize vinyl chloride polymers to inhibit color at high temperature and to protect against decomposition during processing and degradation in

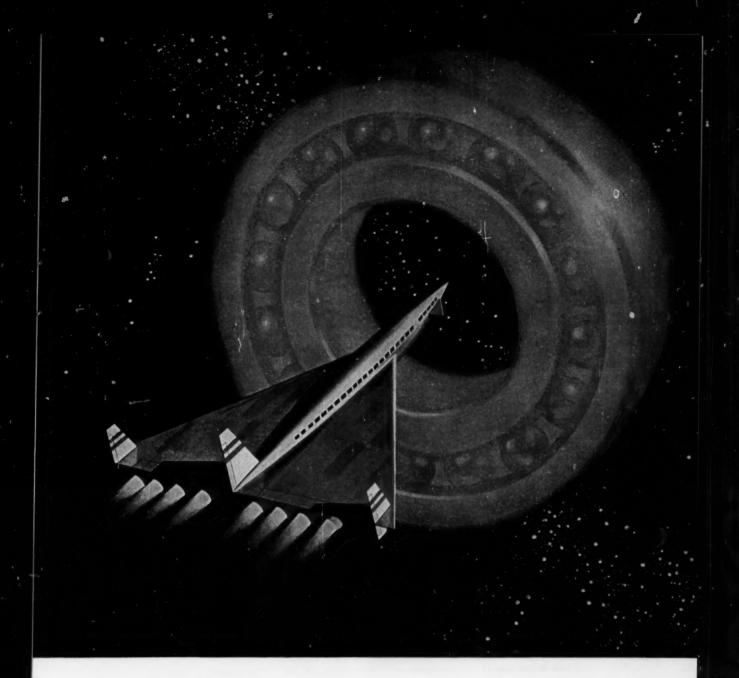
Low linear contraction is a property of high tin content die-casting alloys. Tin alloys shrink very little, permitting close tolerances and very thin walls in such typical small castings as pinions, numbering machine wheels, dashpots of electrical instruments, and gas meter grid valves.

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BEARING WITH A RED HOT FUTURE



Advanced ball and roller bearing technology

On special test equipment in BSF's research laboratory, experimental ball and roller bearings are run at temperatures up to 1000° F and above—conditions under which steel becomes red hot and loses its strength, while conventional lubricants burn or boil away. To meet these problems, bearings made of special heat-resisting alloys and exotic new materials are tested and evaluated. New ideas in design and new approaches to lubrication are constantly being investigated.

Bearings to resist extremely high temperatures are needed for improved, high performance jet engines, gas turbines and other equipment. Special BRSF bearings have been tested successfully in environments at about 1000° F. Under certain conditions of operation, much higher temperatures are practical.

Research like this is your assurance that SEF will always keep pace with demands for the highest possible performance in all major types of rolling contact bearings—ball, cylindrical roller, spherical roller, tapered roller and precision miniature. SEF Industries Inc., Philadelphia 32, Pa.

Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Universal Joints

Catalog 61-D gives information on sizes and types of universal joints for all industrial applications to 1750 rpm. Pictures, drawings, and tables provide all dimensional data for both standard and heavy-duty units. Section on joint operating recommendations is included, with pictures of correct and incorrect use of joints. 8 pages. Lovejoy Flexible Coupling Co., 4949 W. Lake St., Chicago 44, Ill.

Circle 601 on Page 19

Stainless Steel

New bulletin provides data on Uniloy 303MA, a free-machining stainless steel which has advantages over AISI Type 303. Bulletin includes composition, physical and mechanical properties, corrosion resistance data, and list of sizes and shapes presently available. Pictures are used to compare properties of the two types of stainless. 12 pages. Universal-Cyclops Steel Corp., Bridgeville, Pa.

Circle 602 on Page 19

Arc-Welding Products

Information concerning full line of arcwelding products is contained in Bulletin 7000.7, "Weldirectory of Arc Welding Electrodes, Equipment, and Supplies." Bulletin presents information on AWS electrode classification and discusses correct electrode selection for every type of welding application. Arc characteristics, welding procedures, and physical properties are listed for each electrode. 40 pages. Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17, Ohio.

Circle 603 on Page 19

Socket Screws

Catalog DM 783 contains information on socket screws with Nylok self-locking insert. In addition to a discussion of the advantages and special features of the Nylok insert, catalog includes technical data on the properties of the nylon, pellet size and location, and dimensional standards available from stock. 6 pages. Bristol Co., Waterbury 20, Conn.

Circle 604 on Page 19

Polyester Resins

"Laminac Polyester Resins for Spray-Up Application" describes spray-up techniques, safety procedures, coloring, and measuring. Laminac resins suggested for spray-up application include Laminac 4106 and 4!52, formulated specifically for this molding technique. Catalyst-concentration chart is included to indicate the volume of catalyst to be used with varying quantities of resin. 4 pages. Plastics & Resins Div., American Cyanamid Co., Wallingford, Conn.

Circle 605 on Page 19

Fire-Resistant Materials

New folder consists of a comprehensive list of all Spauldite fire-resistant industrial plastics which are self-extinguishing as determined by ASTM D635. Brochure includes descriptions, characteristics, and specifications of 15 different plastics of the phenolic, epoxy, melamine, and polyester-laminate types. Also included is information on copper-clad, fire-resistant materials. 4 pages. Spaulding Fibre Co. Inc., 310 Wheeler St., Tonawanda, N. Y.

Circle 606 on Page 19

Precision Switches

Catalog 104 covers a representative selection of precision switches for industrial, commercial, data-processing, airborne, and electronic applications. It presents photographs and condensed descriptions and dimensions of over 200 items, including miniature switches, special-purpose switches, electronic switch-circuit assemblies, lighted pushbutton switches, toggle, limit, proximity, and mercury switches. 20 pages. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, III.

Circle 607 on Page 19

Threaded Fastener

New booklet describes use of the Hi-Lok fastening system in naval shipyard construction work. Photographs and line drawings show how the system operates. Data on materials and sizes, installation accessibility, controlled preload, and benefits are presented. 4 pages. Hi-Shear Corp., 2600 W. 247th St., Torrance, Calif.

Technical Ceramics

New Ceramics Chart 611 provides data on mechanical and electrical properties of AlSiMag ceramics. Selection charts are also provided, as well as graphs of thermal expansion, dielectric strength, volume resistivity, and high-frequency aluminas. 8 pages. American Lava Corp., Chattanooga 5, Tenn.

Circle 609 on Page 19

Steel Tubing

Catalog CS-61 describes both seamless and electric-welded steel tubing. Electricwelded carbon-steel tubing in mechanical and pressure grades, and seamless carbon and alloy-steel tubing in mechanical, pressure, aircraft mechanical, and airframe grades are described. Additional material covers square, rectangular, and other special shapes, and fabricating and forging tubing into finished or semifinished tubular parts. 8 pages. Ohio Seamless Tube Div., Copperweld Steel Co., Shelby, Ohio.

Circle 610 on Page 19

Preimpregnated Materials

Quality and processing advantages unique to preimpregnated reinforced plastics and laminating materials are presented in "Prepregs" booklet. Case studies on how and why more manufacturers are using prepregs, and tables on the resin-reinforcement combinations available, their characteristics and applications, are also included. Many photographs are used to illustrate the applications. Prepreg Div., Society of the Plastics Industry Inc., 250 Park Ave., New York 17, N. Y.

Circle 611 on Page 19

Adapter Fittings

Revised Catalog 4360 on pipe-thread and straight-thread adapters for tubingsystem connections now includes straightthread adapters with new metal sealing rings. Units are pictured, and line drawings and tables present all dimensional data. 16 pages. Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 612 on Page 19

Temperature Controls

Brief descriptions and specifications are given for 17 different types of temperature controls in Catalog MC-203. Included are details on 12 styles of Thermoswitch units, six miniaturized local controls, four fire and overheat detection models, four snap-action controls, and seven electronic controllers. Typical applications are shown. 8 pages. Fenwal Inc., Pleasant Street, Ashland, Mass.

Circle 613 on Page 13

Hydraulic Pumps

Bulletin 261 provides data on Triplex pumps for heavy-duty, high-pressure, high-temperature hydraulic systems, Design features and construction details are pointed out, and complete information on sizes and operating data is also included. 12 pages. Kobe Inc., 24634 Five Mile Rd., Detroit 39, Mich.

Circle 614 on Page 19

A simple, effective, low cost rust and corrosion control that ...

- is easy to apply
- eliminates moisture
- prevents corrosion
- need not be removed

CRC 3-36 has a dual action which first removes moisture from the surface, driving it out of grain boundaries, cracks and pores. It then forms a thin molecular film of approximately 2 microns over the surface and seals it against subsequent deposits of moisture and the action of corrosive atmospheres.



For Castings & Large Machined Parts

A steam turbine manufacturer, after exhaustive tests, now uses CRC 3-36 exclusively to protect metallic surfaces of parts and equipment in various stages of manufacture from deterioration due to corrosion. After standardizing on CRC 3-36, the necessity for stocking, coding and handling a wide variety of products was eliminated. In addition, CRC 3-36 does not have to be removed before subsequent processing. Substantial savings are being realized through the use of

This manufacturer has also found that CRC 3-36 will protect all metallic surfaces from rust and corrosion during shipment.



For Extruded Aluminum

An aluminum manufacturer received complaints that bright aluminum extrusions arrived at distribution points covered with a dull coating of oxide. Exhaustive tests under actual shipping conditions show that an inexpensive coating of CRC 3-36 eliminated oxidation during shipment and that distributors, in turn, could ship bright and shining extrusions months later to customers with no complaints about oxidation. Furthermore the extrusions were ready-to-use as CRC 3-36 does not have to be removed.



For Manufacturing Processes

The manufacture of welding wire poses a corrosion problem from coolants used to lubricate and cool dies used in the rolling or drawing process. One manufacturer of welding wire tried applying CRC 3-36 before running the stock through the mill and obtained excellent results. Now all stock is coated with CRC 3-36-corrosion is controlled and no stocks are lost due to rust.

New! CRC Soft-Seal for Severe Conditions

If you are using expensive interior storage space for metal stocks, dies, jigs and fixtures, these may be coated with Soft-Seal and stored outside to release inside space for productive use.

For further information, write to Corrosion Reaction Consultants,

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The New Cycl-Flex Counter does more than just count. A large variety of control circuits are yours by utilizing its one instantaneous switch and two delayed switches to control your machines or processes. Use this *count control* to automatically operate:

- · The number of molding machine injection strokes
- Number of indexes on a rotary table
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EAGLE SIGNAL COMPANY . Moline, Illinois
A DIVISION OF THE GAMEWELL COMPANY, AN E. W. BLISS COMPANY SUBSIDIARY

Spiral Bevel Gears

New catalog is a design and buying guide which includes specifications and standard for stock spiral bevel gears. Use of the material permits determination of speed ratios, sizes, and horsepower ratings. Line drawings and tables present dimensional data. 6 pages. Perkins Machine & Gear Co., Circuit Avenue, West Springfield, Mass.

Circle 615 on Page 19

Traction Motors

Publication GEA-7309 lists features and advantages of 6\(^5\epsilon\)-in. diam JB traction motors for low-voltage dc electric vehicles. Motors described are rated \(^3\epsilon\) to 3 hp, 12 to 36 v dc. Bulletin contains photographs showing disassembled motor. Charts of typical motor-speed torque curves and tables of ratings and dimensions are also included. 4 pages. General Electric Co., Schenectady 5, N. Y.

Circle 616 on Page 19

Ring Sprockets

Bulletin 1606 contains comprehensive listings of stock ring sprockets for each of seven series of chains. Sprockets for chains from 1.5 through 4.063-in. pitch, with diameters from 44 through 106 in. and bore sizes from 36 through 100 in. are available. Methods of mounting ring sprockets are shown. 8 pages. Cogmatic Div., American-Marietta Co., Milwaukee 1. Wis.

Circle 617 on Page 19

Control-Knob Selection

Slide rule and a wall chart feature finger-tip selection of more than 345 styles of control knobs. All knobs shown on the selector and wall chart meet most recent MS91528B military specification. Requirements are set on the slide rule, and knobs can be picked to satisfy them. Wall chart offers the same data as the selector, plus dimensional pictures of each style of knob. Raytheon Co., Lexington 73, Mass.

Circle 618 on Page 19

Lock Nuts

Catalog 161 shows a complete range of lock nuts, including clinch, weld, special, and semifinished nuts. Complete size ranges, materials available, physical and mechanical requirements, including welding information, are included in the catalog. 20 pages. Grip Nut Co., South Whitley, Ind.

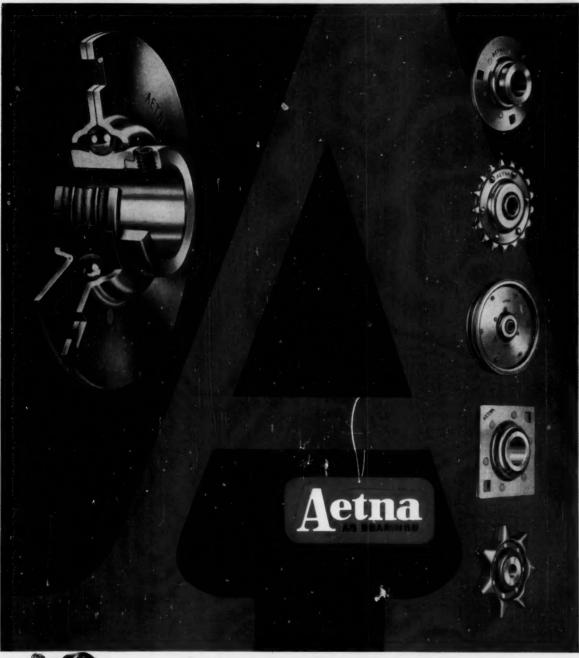
Circle 619 on Page 19

Electrical Equipment

Spring issue of "Helinews" supplies technical information on ac potentiometers, delay lines, panel meters, servomotors, and trimming pots. Many illustrations of the units are included. 8 pages. Helipot Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.

Circle 620 on Page 19

PACKAGED... READY FOR INSTALLATION Put aside your production cost, assembly cost, and stock handling worries. Low-cost Aetna AG Bearings-Adapter Bearings, Belt Idlers, and Regular or Detachable Chain Sprocket Idlers-can solve these problems for you. Each bearing is prepackaged and prelubricated-ready for final installation on your machine. Individual units are simple in design with a single row of balls, an extra large lubricant capacity, and highly efficient seal. They provide dependable performance on all light-duty, medium-speed applications and are available in a wide variety of sizes and configurations. For complete information, call your Aetna representative listed in your classified directory, or write for General Catalog and Engineering Manual.





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✓ less finished weight ✓ multiple coring	1	no assembly required
✓ multiple coring	1	thinner walls or sections
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Send for Bridgeport's Forgings Book which describes how these major benefits can lower costs for you.

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Circle 353 on Page 19

HELPFUL LITERATURE

Precision Springs

"Springs and Springlike Things" summarizes basic information concerning helical springs and assembled spring-like devices. It emphasizes designing for performance, accurate material selection, and quality-control measures. Literature includes design briefs which simplify the specifying of compression, extension, torsion, and flat springs, as well as wire forms. Mechanical properties and recommended uses of commonly used spring materials and cold-rolled spring steels are presented in tabular form. 16 pages. Associated Spring Corp., Bristol, Conn.

Circle 621 on Page 19

Instrument Motors

New engineering periodical, "Instrument Motor Quarterly," contains articles on performance, selection, application, and maintenance of all types of fractional and subfractional-horsepower motors. Lead article of the first issue is on lubrication of instrument motors. Specific applications, with emphasis on how the motor contributes to over-all performance, will be covered in a regular section. 4 pages. Holtzer-Cabot Motor Div., National Pneumatic Co. Inc., 125 Amory St., Boston 19, Mass.

Circle 622 on Page 19

Self-Locking Nuts

New 1961 catalog contains large, complete selection of lightweight, all-metal, self-locking nuts developed for the air-frame, propulsion, and electronic industries. Catalog features a line of floating and nonfloating stake nuts in regular and miniature sizes, and a line of high-strength, thin-wall inserts. About 144 pages. Kavlock Div., Kaynar Mfg. Co. Inc., Box 2001, Terminal Annex, Los Angeles 54, Calif.

Circle 623 on Page 19

Ball Data

New publication contains ball grade conversion tables which compare old and new AFBMA standards. Other sections describe balls from 1/32 to 25% in. diam, giving engineering data on material, hardness, grades, tolerances, corrosion resistance, uses, and magnetic properties. List of definitions involved in ball manufacture is provided. 20 pages. SKF Industries Inc., Front Street & Erie Avenue, Philadelphia 32, Pa.

Circle 624 on Page 19

Air Cylinders

Series A dimensionally interchangeable, 250-psi, cushion-type air cylinders are described in Bulletin 161. Large cut-away drawing is used to point out salient features, and pictures and dimensional drawings are given for each unit. Various types of mounts are shown; tables present dimensional and other data. 20 pages. Sheffer Corp., 326 W. Wyoming Ave., Cincinnati 15, Ohio.

Circle 625 on Page 19



has a faster, more rugged AIR MOTOR



Truly a convenience package, the Hannifin Air Motor combines a rugged, low-friction, double-acting air cylinder with a solenoid valve. Ample air passages permit rapid cycling. Built-in speed controls make it possible to slow either or both strokes. Mounting dimensions interchange with most existing applications. "Off shelf" delivery in "standard" strokes. Bulletin 215—free on request —describes this new product.

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The Temperature Control Powered by the

IRREPRESSIBLE FORCE OF MERCURY-

for Accuracy with Rugged Dependability



All Partlow temperature controls are directly and positively actuated by mercury, the metal in liquid form whose reaction to changes in temperature is as predictable as it is powerful.

Unlike delicate electronic controllers, the mercury-actuated Partlow requires no outside power source. No amplifiers. No finicky levers. And no "babying"! With a Partlow you can be sure of getting accurate, dependable control even under extreme conditions of shock and vibration.

Mercury-actuation makes possible maximum design efficiency and simplicity too. The Partlow has fewer parts to go wrong. And fewer service problems (with less "down" time) should trouble occur. You can replace the thermal element of any Partlow control instantly, right at the job site, without recalibrating, fitting or factory adjustment.

Whatever the process or application, you'll find a Partlow temperature control to fit it dependably, economically, precisely. Mail coupon today for full details.



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THE PARTLOW CORP., Dept. D-561
NEW HARTFORD, N. Y.
Please send condensed Catalog of Partlow temperature and allied equipment for industrial heating and refrigera

Company

controls



Silicone Uses

Catalog CDS-129C describes a complete line of silicones and their uses. Catalog contains data pertaining to the various silicone products, including a complete selector guide for silicone rubber. Four general categories deal with silicone fluids, silicone protective coatings, silicone electrical insulation, and silicone rubber. Product types are grouped under appropriate end-use headings. 8 pages. Silicone Products Dept., General Electric Co., Waterford, N. Y.

Circle 626 on Page 19

Zener Diodes

"The Zener Diode," Bulletin PA-502, covers zener-diode theory, characteristics, and applications. Typical circuits using zener diodes are shown. Advice on the use of the diodes in series, as well as in parallel, is included. 4 pages. CBS Electronics. 100 Endicott St., Danvers, Mass.

Circle 627 on Page 19

Flexible Motor Couplings

Folder 2975 on Type MC geared flexible motor couplings brings together all pertinent data on company's motor couplings, including three new features. These are a new corrosive-duty cover, new spacer, and a larger size. Couplings described are designed specifically for use as motor couplings for transmitting power to pumps, compressors, generators, speed reducers, and similar applications. 6 pages. Link-Belt Co., Prudential Plaza, Chicago 1, Ill.

Circle 628 on Page 19

Carbon-Graphite Materials

Bulletin S-5425 is an illustrated engineering guide on carbon-graphite materials for mechanical applications. Grade recommendations are presented for seals and sliding surfaces for a wide range of liquids and gases at operating temperatures to 500 F, above 500 F, and in the cryogenic range. Bulletin tabulates 18 grades of company's carbon, graphite and carbon-graphite available for mechanical uses, and lists properties for each grade. Table of design tolerances is also included. 8 pages. National Carbon Co., Div., Union Carbide Corp., 270 Park Ave., New York 17, N. Y.

Circle 629 on Page 19

Swage Nuts

Form 2701 provides detailed specification, installation, and performance information on self-locking swage nuts designed for installation in thin metals. Performance data includes size-by-size tabulation of minimum tensile strengths in pounds for both coarse and fine threads. Bulletin tabulates average push-out and torque-out values and also recommended assembly pressures. Illustrations help explain swaging principle and three-point locking action of the nuts. 4 pages. Standard Pressed Steel Co., Jenkintown, Pa.

Circle 630 on Page 19



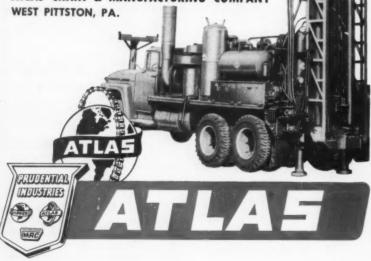
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Silver-Brazing Alloys

Form ADC 847C discusses silver-brazing procedures, problems, and solutions. All silver-brazing alloys are thoroughly discussed, stressing advantages and applications. Easy-to-read diagrams help select the proper alloy to meet particular industrial needs. 24 pages. Air Reduction Sales Co., Div., Air Reduction Co. Inc., 150 E. 42nd St., New York 17, N. Y.

Circle 631 on Page 19

Ball Valves

Comprehensive information on manually and pneumatically operated ball valves in sizes from ½ through 12 in. is given in Catalog 1200. McCannascal top-entry and McCannaflow valves are cataloged in detail. Dimensions and weights, material specifications, typical C_v values, and pressure-temperature rating charts are provided. Five pages are devoted to the suitability of standard body materials and various seat materials for a wide range of chemical services. 32 pages. Hills-McCanna Co., 400 Maple Ave., Carpentersville, Ind.

Circle 632 on Page 19

Nozzles, Accessories

Bulletin 106 describes complete line of spray nozzles and accessories specifically used in the metal-finishing field. Reference chart lists applications and types of nozzles used. Booklet provides a complete spray-nozzle reference manual on washing, rinsing, fogging or wetting, coating, and related operations. 8 pages. Spraying Systems Co., 3274 Randolph St., Bellwood, Ill.

Circle 633 on Page 19

Aerospace Materials

Structural materials for aerospace applications are discussed in Booklet JI 92509. Development facilities for pure metals, alloys, ceramics, and plastics are described, along with examples of some long-life space structure components that have been produced. 8 pages. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Circle 634 on Page 19

Control Valves

Bulletin 5000 describes new control and line valves deseignated Spanseal. Large diagrams show how the units work, and also point out outstanding features. Many flow diagrams and photographs are shown. 8 pages. Ledeen Inc., 3350 N. Gelman Rd., El Monte, Calif.

Circle 635 on Page 19

Glass Products

Booklet 760 details many products which can be designed of glass. Properties of the material are described and illustrated, and applications are also illustrated. 18 pages. Kopp Glass Inc., Swissvale, Pa.

Circle 636 on Page 19



bearings and parts

Take the simple, sure, direct route to lower manufacturing and maintenance cost. Design into your product Bunting Standard Stock Bearings. You avoid inventory investment, delays, confusions, production problems by the immediate availability in small or large lots, from local distributors all over America, of hundreds of different stock sizes of completely finished cast bronze and sintered bronze bearings and bars, aluminum bars and Nylon shapes.

Special design bearings not obtainable from stock can be procured immediately at low cost from Bunting fully equipped machine shops in five industrial centers. The wide range of sizes of Bunting Stock Cast Bronze and Sintered Bronze Bearings makes the alteration of a stock item to a special bearing easy and economical. Bunting Cast Bronze, Sintered Bronze, Aluminum Bars and Nylon shapes provide the materials for special requirements which cannot be made from stock bearings. Your local Bunting Distributor can arrange for such work.

A large staff of bearing engineers in the field stands ready to assist in the use of these Bunting stock products and in the designing of bearings or components for extraordinary applications. Two big, modern plants assure ample production capacity at all times for bearings and parts made from all modern metals and materials.

See Bunting's complete catalog, Sweets Product Design File 11C/BU or ask for Bunting's General Catalog, Form 158; Nylon Catalog, Form 22; Technical Handbook on Bunting Nylon, Form 33; The Technology of Bunting Aluminum, Form 46; Engineering Handbook of Powder Metallurgy, Form 1; Bunting Machine Shop Service, Form 4.

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HELPFUL LITERATURE

Wire-Wound Resistors

Line of miniaturized, wire-wound resistors is described in new two-color catalog. It features a comprehensive manual of terms and definitions, and diagrams and specifications on 20 standard axiallead and printed-circuit-type resistors. Also included are a table describing the characteristics of resistance wire, and a table describing the relation between maximum possible resistance and wire types. 6 pages. Ortho Precision Resistors Inc., 7 Paterson St., Paterson 1, N. I.

Circle 637 on Page 19

AC Motors

Complete line of Duty Master ac motors rated from 1 to 2000 hp is shown in Bulletin B-2515. Product features of each motor are outlined and explained for selection of the correct motor for every application. Full-color bulletin utilizes cutaway drawings to point out special features. 16 pages. Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.

Circle 638 on Page 19

Power Supplies

New 1961 dc power-supply handbook and catalog details over 200 power supplies plus 1 million combinations of modules in kit form. Manual includes a stepby-step procedure for calculation of packaging dimensions for multiple dc outputs. Considerations include spacing problems for modular de power supplies under various conditions of ambient temperature, external cooling, and rated current. 24 pages. Dressen-Barnes Electronics Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Circle 639 on Page 19

Shunt-Grade Wire

Two-color bulletin describes the properties, characteristics, and possible applications of Manganin shunt-grade wire, an alloy of copper, manganese, and nickel. Using illustrations, charts, and diagrams, bulletin describes the resistance and weight, physical characteristics, resistance change vs. temperature, and other details of the wire. 4 pages. Molecu Wire Corp., Eatontown-Freehold Pike, Scobeyville, N. J.

Circle 640 on Page 19

Pressure Transducer

"Biography of a Very Versatile Pressure Transducer" describes the TP 200 line of pressure transducers. Brochure contains performance data on six different versions of the unit which can be used for measuring absolute, gage, or differential pressures of corrosive or noncorrosive gases or liquids with static or dynamic inputs in the ranges of 0-5 to 0-500 psi full-scale. It also includes photographs, outline drawings, and cutaway views of the various units. 4 pages. Fair-child Controls Corp., 225 Park Ave., Hicksville, L. I., N. Y.

Circle 641 on Page 19

DESIGNING

new equipment?

IMPROVING

old equipment?

SPECIFY

LOWELL

REVERSIBLE RATCHET

MRENCHES

for component parts





- · modification of a standard wrench . . .
- · a special or unusual wrench . . .
- an entirely new design for your job . . .

Lowell design/engineering service is anxious to help with all types of problems involving turning adjustments on new or old equipment.

Modification of a standard ratchet wrench may provide a simple, inexpensive solution.

Or one of the many specials we have developed for unusual applications might well be the answer. It could be a bent, hinged or detachable handle; a long or odd-shaped socket; remote reversing control; special materials or finishes.

And if the problem requires an entirely new wrench or related ratchet device, we welcome the chance to help. Save yourself time . . . and rely on our wide experience with designers for the most economical solution.

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Heat Radiators

Catalog 1-HR describes transistor/diode heat radiators available from stock. Details and drawings of more than 72 semiconductor radiators are listed for most TO case outlines. Catalog also includes a comprehensive handbook on thermal cooling, information on semiconductor installation, formulas on thermal runaway, a transistor derating curve and formulas, thermal/electrical analog, and formulas on heat dissipation by radiation, convection and conduction. 16 pages. Industrial Div., Birtcher Corp., 745 S. Monterey Pass Rd., Monterey Park, Calif.

Circle 642 on Page 19

Wire and Strip Construction

New booklet contains engineering data and case histories on construction of metal components or products of wire or wire-strip. Discussion of types, sizes, and strengths of wire is provided, and illustrations show types of welds and wire-end treatments. Data is also given on rolled thread and wire rings. Representative products are shown. 24 pages. E. H. Titchener & Co., 68 Clinton St., Binghamton, N. Y.

Circle 643 on Page 19

Power-Cylinder Accessories

New reference bulletin provides a method for quick identification of mounting accessories for square-type, industrial hydraulic and pneumatic power cylinders. Described and fully cataloged are female rod clevis, female rod eye, clevis bracket, mounting plate, and pivot pin. With knowledge of bore size and rod thread size, and using the bulletin as a reference, proper accessory or set of accessories can be selected easily. 2 pages. Hannifin Co., 501 S. Wolf Rd., Des Plaines, Ill.

Circle 644 on Page 19

RF Connectors

New two-color, loose-leaf catalog contains illustrations and full technical data on complete line of RF connectors, including K-Grip units. Also included are telephone jacks and plugs as well as connectors designed for specific applications. A 15-page cross-referencing index gives company number and comparable military number for each unit. 120 pages. Write on company letterhead to Kings Electronics Co. Inc., 40 Marbledale Rd., Tuckahoe, N. Y.

Cryogenic Instrumentation

Illustrated Bulletin CG 112R describes activities in the field of cryogenic instrumentation. Folder contains information on equipment to measure accurately such parameters as temperatures, pressure, flow, and liquid level for use in cryogenic environments. Specifications and schematics for thermocouples, liquid-level detectors, and vapor-pressure thermometers are included. 4 pages. Write on company letterhead to Cryogenics Inc., Stafford, Va.

Circle 360 on Page 19→

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NYLINES

-BEARINGS of smooth, tough DuPont NYLON



Low Cost FLANGED Nyliner



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COST LESS to BUY COST LESS to INSTALL ELIMINATE LUBRICATION

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Engineered to Solve Problems . . . Improve Products . . . Reduce Costs!

NYLINER Bearings are a highly engineered thin liner of DuPant Nylon, designed to bring bearing users the many benefits of Nylon as a bearing material by solving most of the limitations surrounding its use. The compensation gap principle assures maintenance of diametral tolerances for precision applications.

Seven Standard Types available from stock. Write for literature and name of your local representative who stocks NYLINER Bearings for immediate shipment.



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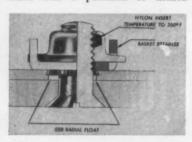
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Floating Clinch Nut

is miniaturized, self-locking unit

Type NC4284 floating clinch nut, a self-retained blind fastener, provides load-bearing threads in thin sheet-metal assemblies. Nut with two small lugs is retained in a window-type basket which provides 0.020-in. radial float. Nut automatically compensates for minor bolt-hole misalignment of the components being attached. Bracket also has a short, knurled shank which is swaged flush into a punched or drilled



hole in aluminum or soft steel sheets. Nut is manufactured from carbon steel and 18-8 stainless in sizes No. 4, 6, 8, and 10. For each thread size, a series of three baskets with alternate shank lengths of 0.040, 0.060, or 0.090 in. is offered for flush installation in sections of equivalent thicknesses. Locking device is a red nylon insert which withstands temperatures to 350 F. Elastic Stop Nut Corp. of America, Union, N. J.

Liquid Spring Shock

absorbs 175 lb-in. energy in 1/10-in. stroke

Miniature Model 409.8 SS liquid spring shock has a length of $1\frac{1}{8}$ in. and OD of $\frac{1}{2}$ in. It absorbs 175 lb-in. of energy in 1/10-in. stroke. The 800-lb spring force operates in 1/10-in. stroke with 80-lb



preload to 0.04-in. stroke with 400-lb preload. Unit weighs 1 oz, and is stainless steel. Taylor Devices Inc., 200 Michigan Ave., North Tonawanda, N. Y.

Circle 646 on Page 19

Silicone Rubber

resists low temperatures

SE-5401U silicone-rubber compound is available for use in molded and extruded seals and gaskets and in a wide variety of mechanical applications. It resists extremely low temperatures, and can be used to meet specifications MIL-R-5847D, Class I, Grade 40, and AMS-3334. Silicone Products Dept., General Electric Co., Waterford, N. Y.

Circle 647 on Page 19

Electric Motor

is permanent split-capacitor type

Type CR fractional-horsepower electric motor has $4\frac{7}{8}$ in. diam. The permanent split-capacitor unit com-



bines high starting torques with increased efficiency. Low current requirements result in less heat rise, make the motor cool running and long lasting. Unit is available in both four and six-pole design, from 1/20 to ½ hp. Redmond Co. Inc., Owosso, Mich.

Circle 648 on Page 19

Precision Shaft Locks

for 1/8 and 1/4-in. shafts

Improved precision shaft locks are available for use on potentiometers, capacitators, coils, and other shaft-type controls. Knurled hand nut or wrench hex nut styles are stocked. The collect-type locks are available for ½ and ¼-in, shafts in clear passivated stainless steel or black



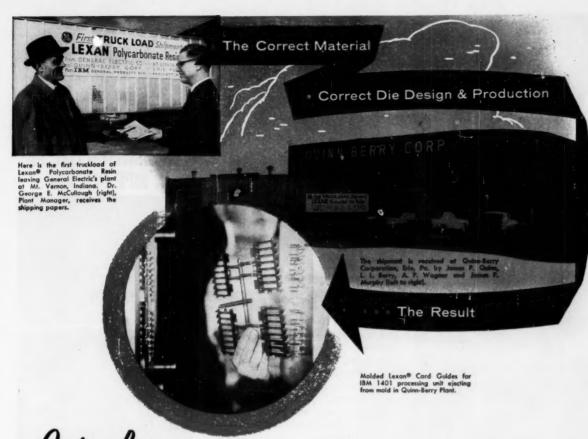
anodized aluminum. PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

Circle 649 on Page 19

Vane-Pump Cartridge

subminiature unit can be used in many fluid systems

Small size and flexibility of integration into many types of fluid systems are advantages of a subminiature vane-pump cartridge. Unit has $\frac{3}{4}$ in. diam, and weighs 1 oz. It delivers 0.1 to 1.3 gpm at pressures from 50 to 1500 psi. Displacement is 0.003 to 0.013 cu in. per revolution, and speed range is 8000 to 26,000 rpm. Cartridge is constructed of various metals, plastics, or



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KNOXVILLE, Tennessee Melloy Sales Inc. P. O. Box 3207—Zone 17 2643 Kingston Park S. W. IBM Bidg. Phone: Knoxville 522-5911

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ARDMORE, Pa. Austin L. Wright Co. P. O. Box 561 1 W. Lancaster Ave. Midway 2-5113

The Requirement:

To produce Card Guides molded to close tolerances for IBM processing unit 1401, excellent dimensional stability must be maintained over a wide range of service conditions.

General Electric's Lexan® polycarbonate resin was chosen to meet the desired requirements.

Skillful mold design and expert craftsmanship in the press room teamed up at Quinn-Berry to meet accurately these rigorous demands.

The Result:

Quinn-Berry molded IBM Card Guides help maintain card position during card processing, hold required dimensional stability regardless of thermal changes, have extreme resistance to impact and are self-extinguishing.

At Quinn-Berry, where the Unusual is Routine, The Result is Our Most Important Product.

Consult with us on your routine or unusual molded thermoplastic parts requirements.



42



Magnetic

Iron and steel particles that wear off moving parts and circulate in the lubricant are a primary cause of wear to bearings, bushings, gears, cams, etc.

The powerful magnet in the Lisle Magnetic Plug pulls these particles out of the lubricant — assuring longer, quieter, trouble-free, operation of your product.

Lisle Magnetic Plugs can be used in place of any ordinary drain or fill plug.

FREE Samples for Testing in Your Product!

CORPORATION Clarinda, lowa

Circle 362 on Page 19



ceramics to be compatible with material being pumped. Vickers Inc., Div., Sperry Rand Corp., Detroit 32, Mich.

Circle 650 on Page 19

One-Component Coating

for electronic components

HumiSeal 1F19 one-component coating is suitable for use on capacitors, resistors, transistors, diodes, coils, armatures, motor windings, other electronic components. transparent coating dries at room temperature, becoming tack-free within 30 min, and is then ovencured. It is suitable for operating temperatures from -90 to +350 F. Coating provides resistance to moisture, chemicals, corrosive gases, fungus, weathering, salt spray, and aging. It has excellent adhesion, abrasion resistance, flexibility, and insulating properties. Columbia Technical Corp., 24-30 Brooklyn-Queens Expressway, West, Woodside 77, N. Y.

Circle 651 on Page 19

Plastic Protectors

are used as caps or plugs

GP protectors are for all threaded and nonthreaded parts in a range from ½ to 2½ in. Usable either as a cap or a plug, they eliminate special sizes and reduce inventories. Made of tough, nonshredding elastic polyethylene, protectors can be applied to machine-screw threads





CURTIS HELPS THIS SWITCH LIVE TO A RIPE OLD AGE





Pad-mounted transformers for underground power distribution systems are built to last a lifetime. They require a minimum of maintenance. Settings are changed infrequently. But when a change is required, this switch must operate smoothly and surely. To insure a long, dependable life, without freeze-ups or rust-outs, the manufacturer equipped it with a Curtis C-646 1" O.D. Stainless Steel double universal joint.

This kind of dependability is the stock-in-trade of Curtis joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, continuous testing, inspection and quality control at every stage of manufacture — these are some of the things that make Curtis joints your most dependable buy.

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55 Birnie Ave., Springfield 7, Mass.
As near to you as your telephone. Exclusively a manufacturer of universal joints since 1919

All-plastic case shows finely drawn functional detail— Tube, lens ring, and cap are all molded of BAKELITE Brand high-density polyethylene. The designer made good use of this material's functional properties. Fine details are reproduced with fidelity—serrations on the tube are pre-cisely formed and provide a firm grip. Minimum finishing after molding helps keep mass production costs low. Tough and rigid with excellent chemical resistance, the flash-light will take hard usage. Its gloss adds sales appeal. On top of all these design advantages, the low price of this material makes it an even stronger value.

NOTE: EXTERIOR SURFACE OF TUBE TO BE FREE OF ALL PARTING LINES NOTE: SERRATIONS TO RUN OUT AT BOTTOM END OF TUBE

Molded-in threads, hidden parting line make this design unusual-Because of the high temperature resistance of BAKELITE Brand high-Because of the high temperature resistance of BAKELITE Brand nightensity polyethylene, these flashlight components always hold their shape. The molded ten-pitch threads don't soften, keeping the lens ring and cap firmly in place.

While the threaded sections at the bottom and top of the tube required a parting line, the designer specified that the main body of the tube have no parting line. The one-piece mold used for



parting line. The one-piece mold used for this feature costs more, but the appearance of the finished product makes it worth-while. A slight taper in the tube permits easy removal from the mold. Since holes for the switch plate are molded in, there's no need for drilling or piercing.

HIGH-DENSITY POLYETHYLENE ... Idea-material for new designs

The Eveready "Shop Lite" gained several advantages when the designer chose this new polyethylene. Check the high points on this page . . .

A new material often expands the designer's opportunities to try new ideas. This is especially true of high-density polyethylene, which offers properties that can reduce costs, extend performance, and improve appearance. Polyethylenes are only one group of BAKELITE Brand Plastics - the others are epoxies, phenolics, styrenes, and vinyls-that you can draw on. Molded, laminated, extruded, and in coatings, BAKELITE Brand plastics can be a source of genuine product improvement.

Check their properties in Sweet's Product Design File, Section 2a/ui.

Clean mold gating, color, feature high-density polyethylene — The designer called for a conventional gate on the flashlight cap mold; the tube and lens ring molds have a "diaphragm" gate used in fabricating tubular plastic de-signs. See how the finished part com-pares with his design. The cap and lens ring come in three glossy colors — red, vellow, and green—an attractive combiyellow, and green—an attractive combination with the black tube.





UNION

BAKELITE, EVEREADY, and Union Carbide are registered trade marks of Union Carbide Corporation.



This was an informal test-but it demonstrated the toughness and impact resistance of the BAKELITE Brand high-density polyethylene used in the EVEREADY "Shop Lite." It came through the bump, bounce, and batter undamaged.

Dept. JF-84E, Uni	ion Carbide Plastics Company
Division of Union	Carbide Corporation
270 Park Avenue,	New York 17, New York

Please send me information on the use of BAKELITE Brand plastics in design with particular emphasis on these properties

The type of application being considered is

NAME	 	
FIRM NAME	 	
STREET	 	

STATE



They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66-MD.

(male and female), pipe threads (male and female), and tubing (both ID and OD). Plastic is highly resistant to acids, alkalies, caustics, petroleum-based products, and most common solvents. It has temperature stability from -95 to +175 F, with high dimensional stability. S. S. White Industrial Div., 10 E. 40th St., New York 16, N. Y.

Circle 652 on Page 19

Variable-Speed Belting

in single or twin-link types



Adjusta-Link variable-speed belting in link form for quick, easy adjustment to any required length is now available in single or twinlink types in widths from 7/8 to 4 in. Belting fits all V-to-V drives and is interchangeable with all endless molded and wood-block belts. Links are die cut and precision made, and belting is heat and oil-resistant. It can be installed or detached with pliers and a simple hook tool. Longitudinal flexibility permits easy flexing around small diameter pulleys. Love oy Flexible Coupling Co., Dept. MD-1, W. Lake St., Chicago 44, Ill.

Circle 653 on Page 19

Lead-Sulfide Photocells

are all-glass, hermetically sealed units

Lead-sulfide infrared cells are for use in such equipment as electronic computers, sound projectors, temperature-measuring devices, infrared communications apparatus, missileguidance systems, fire detectors, and solar temperature computers. Allglass, hermetically sealed cells are

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allows up to 4" lateral displacement

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gives you longer service life!

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Fits all standard pitch sprockets



Write today for new Tuf-Flex folder. Gives engineering features, construction details, specifications and prices...

DIAMOND CHAIN COMPANY, INC. A Subsidiary of American Steel Foundries Dept. 618 - 402 Kentucky Avenue Indianapolis 7, Indiana





ROLLER CHAINS

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Circle 366 on Page 19

BOOTH 1228-1232

DESIGN ENGINEERING SHOW
NEW COBO HALL . DETROIT, MICH.
MAY 22-25, 1961

See Tuf-Flex, Duraweld, Micropitch and other new Diamond Chains

Need Thinner & Wider Precision STAINLESS and SPECIAL ALLOYS in THIN STRIP and FOIL?



Rodney
Specializes in
Close-Tolerance
Thinness...
Unique Service
Described in
Free Catalog!

Rodney concentrates its entire efforts, research and production, toward furnishing super thin, extra wide, precision rolled, metal strip and foil in all tempers and finishes. With the entire capacity of plant and personnel devoted exclusively to this specific area, Rodney can offer the added "know-how", manufacturing experience, quality control, and application knowledge your operation may require.

Rodney produces stainless steel strip ... all alloys ... in widths from 1/6" to 24" ... at gauges from .012" to .0003". Rodney also rolls high temperature alloys and other special alloys on a production basis. Aluminum alloys, carbon steel strip and specialty custom rolling are also handled.

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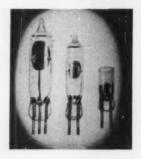
RODNEY METALS, INC.



RODNEY ROLLED IS

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Mill: Rodney French Blvd., New Bedford, Mass. Executive Offices: 261 Fifth Avenue, New York 16, N. Y. Wést Coast Office & Warehouse: 5462 East Jillson St., Los Angeles 22, Calif. NEW PARTS AND MATERIALS



environmentally stable with pins for socket mount or with flexible leads. Broad range of stock sizes is broken down into several sensitivity ratings. Cetron Electronic Corp., 715 Hamilton St., Geneva, Ill.

Circle 654 on Page 19

Vinyl Sheeting

for vinyl-to-metal applications

Boltaflex 500 semirigid vinyl sheeting is available for highly styled and decorative vinvl-to-metal applications. Material offers a wide variety of patterns, colors, and embossings. It is available in thicknesses from 0.010 to 0.020 in., in a wide range of widths, and in any color range. Sheeting resists chemicals, weather, and humidity. Finished material withstands acids, alkalis, alcohols, household detergents, salt water, industrial liquids, and corrosive atmospheres, Pennsylvania Div., General Tire & Rubber Co., Akron, Ohio,

Circle 655 on Page 19

Shaft Seals

can be assembled and disassembled by hand

Tak-Apart seals feature a universal design that permits mass production for stock in catalog materials and sizes up to 4 in. They are easily disassembled and reassembled by hand. Seals conform to all standard



SPHERCO BEARINGS



If you have applications involving linkage or transfer of motion, SPHERCO Bearings can supply your needs in a wide variety of materials with a quality that will give you top performance under normal or high temperature conditions.



WRITE FOR BULLETIN 560



Circle 367 on Page 19

specify accurate instruments

TO MATCH THE QUALITY OF YOUR PRODUCTS

The quality of many a product is complemented by quality instrumentation. That is why many new machines come equipped with American Thermometers, Ashcroft Pressure Gauges, and American Temperature and Pressure Regulators.

We produce these temperature and pressure indicating and regulating devices in great variety for application by original equipment manufacturers. The reliable service these instruments give is also appreciated wherever industry must measure and regulate process temperatures and pressures.

Complete specifications available on request. Mail the coupon for catalogs.

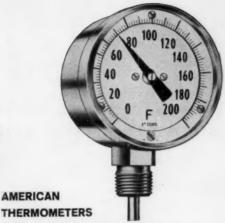


Fastest response is provided by these American Regulators because: 1) the stem can't bind and retard valve action; 2) a bellows seals off the stem and makes practical a non-leaking packless valve. They are self-operated – need no outside power to control temperatures and pressures. Maximum use is made of stainless steel and bronze. Regulator sizes: For temperature—½" to 4". For pressure—½" to 2". Operational ranges: temperatures as low as —15°F. to 50°F.; as high as 240°F. to 340°F. Pressure—250 lb. design.

MANNING, MAXWELL & MOORE, INC.



Gauge and Instrument Division • Stratford, Connecticut Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario



Two outstanding characteristics of these American Bi-Metal Thermometers are 1) precision manufacture to assure sustained accuracy; 2) the unique Maxivision® dial that eliminates parallax errors. Stainless steel construction safeguards against corrosion. Hermetically-sealed models meet the severest service conditions. Dial sizes: 2", 3", and 5". Temperature ranges to suit the application. All types of connections. Stems to 24"; wells to fit all lengths.



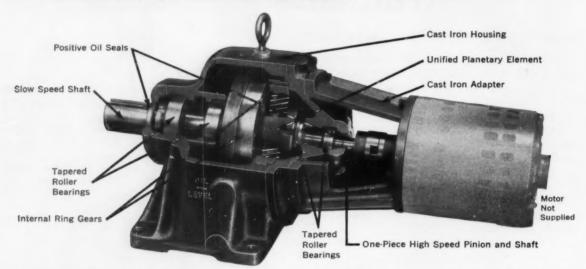
These Ashcroft Steel Case Gauges are used on many portable compressors, pumps, and regular pressure lines. They are Bourdon-tube-equipped gauges in pressure, vacuum, and compound types. Brass movement is of precision design. Special heavy-duty movements also available. Pressures range from 15 psi to 600 psi. Dial sizes: 2", 2½", and 3½". Pulsation dampeners, gauge savers, needle valves, and other accessories available. Make your selections to fit the application. Other gauges in the Ashcroft line include Duragauge, Maxisafe, pneumatic receiver, recording, chemical, test gauges, and master reference gauges.

Manning, Maxwell & !	Moore, Inc.
East Main Street, Strat	ford, Connecticut
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☐ American Thermometer	
☐ Ashcroft Gauge Catalo	0
☐ American Regulator B	ulletins 114C and 116
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Engineering Data



HORIZONTAL MOTORIZED DIFFERENTIAL SPEED REDUCERS



CAST IRON HOUSING—designed for high heat radiation. One-piece construction, close-grained gray iron for maximum strength and rigidity.

UNIFIED PLANETARY ELEMENT—integral primary and secondary planetary gears, mounted in a ductile iron cage—for even wear, equalized load, smooth operation. Hardened and ground, alloy steel gears carry entire power transmission load.

CAST IRON ADAPTER—permits use of any standard "C" flange motor. Flexible coupling (optional) connects motor to input shaft which can be driven in either direction.

INTERNAL RING GEARS—primary and secondary. Cut from alloy steel, heat treated for wear resistance.

ONE-PIECE HIGH SPEED PINION AND SHAFT-machined from

alloy steel with teeth cut integral with the shaft. Hardened and accurately ground to close limits.

SLOW SPEED SHAFT—heat treated, precisely ground alloy steel. Low speed gear web of ductile iron.

TAPERED ROLLER BEARINGS—opposed pairs support the radial load, take thrust, ensure permanent alignment of both input and output shafts.

POSITIVE OIL SEALS—chevron type, keep oil in, dirt out. Oil and heat resistant, non-abrasive, low coefficient of friction.

AVAILABLE in any ratio from 1.1:1 to 50,000:1 without increasing the number of parts. Each model has a range of reduction ratios. Overall dimensions of individual models do not change regardless of ratio.

- 7 Models
- .12 to 81.51 H.P.
- Ratios 1.1:1 to 50,000:1
- Max. Output Torque 50 to 113,000 in. lbs.

Series HM Horizontal Motorized Speed Reducers are a part of the Winsmith Planetary Differential Reducer line. They feature cuttooth helical gears of 15° helix angle for smooth, positive power transmission—greater load carrying capacity—larger reduction ratios in smaller, more compact units—minimum wear and long service life. Winsmith Horizontal Motorized Differential Reducers are easy and convenient to install, require no bedplate, deliver more horsepower per pound of weight and cubic foot of space, and permit easier integration with the driven machine.

Write today for complete information or call your nearest Winsmith Representative listed in the Yellow Pages. He is a technically trained expert who is always ready to help you with any speed reducer problem. For both standard and special power transmission applications, you'll find it pays to standardize on Winsmith.

WINSMITH, INC.

202 Eaton Street, Springville, (Erie County), New York



• • • Winsmith Speed Reducers are made by American craftsmen to meet American design and production standards,

face-type, cartridge-seal dimensions, directly replacing other standard cartridge seals. Standard O-ring packing and Tellon-coated inner scaling surface provide good sealing efficiency. Lightweight aluminum in both adapter and outer shell minimizes inertia losses. Gits Bros. Mfg. Co., 1866 S. Kilbourn Ave., Chicago 23, Ill.

Circle 656 on Page 19

Germanium Tunnel Diodes

feature tightly controlled low peak currents

Four microwave-frequency germanium tunnel diodes are housed in a new miniature package. They feature tightly controlled low peak currents, resulting in high negative



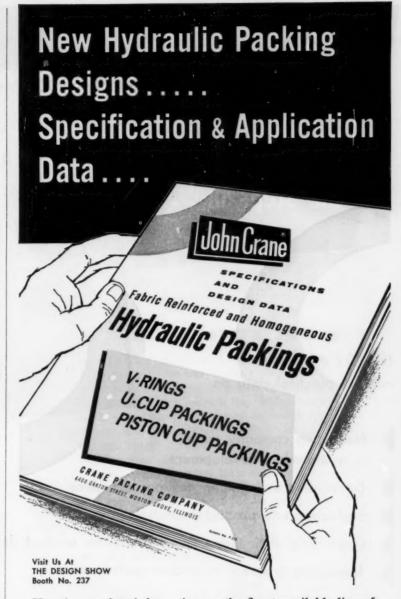
resistance. Devices are also designed for application in radar, very-high-frequency amplifiers and oscillators, and other S-band equipment. Two of the diodes operate at frequencies to 3500 me and the other two at frequencies to 4600 me. Typical inductance is 0.4 millimicrohenries. JEDEC designations are 1N3218, 1N3218A, 1N3219 and 1N3219A. Devices have typical total capacities of 7, 4, 14, and 7 picofarads, respectively. Semiconductor Products Dept., General Electric Co., Kelley Building, Liverpool, N. Y.

Circle 657 on Page 19

Digital Readout

mounts in 1 x 3.1-in. panel space

New self-decoding readout, designed as a complete package, mounts in a 1 x 3.1-in. panel space and extends 2.5 in. behind the panel. Instrument decodes either binary inputs or pulse trains, and displays information in digital form. Sixteen



Here is complete information on the finest available line of hydraulic packings... an extremely wide variety of types and constructions, each correctly compounded to particular service requirements and laboratory controlled to insure uniform quality. Available now from "John Crane", this complete line is the answer to practically every hydraulic packing requirement.

Request Bulletin P-333. You can't afford to be without this detailed engineering guide.

Crane Packing Co., 6425 Oakton Street, Morton Grove, Illinois (Chicago Suburb). In Canada: Crane Packing Company, Ltd., Hamilton, Ont.



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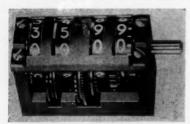
3/4 x 11/4-in. alpha-numerical characters are displayed at any rate up to 50 characters per second. Readout is lighted by two incandescent bulbs, wired in parallel, so that if one bulb burns out, the other continues to illuminate the display. Sealed construction, long life, and light weight qualify the instrument for all types of military and commercial applications. It operates on 12 or 28 v dc. Datascope Corp., 4023 Irving Place, Culver City, Calif.

Circle 658 on Page 19

Miniature Angle Counter

provides readings from 000.0 to 359.9 deg

Model 11646 miniature angle counter is less than 3/4 in. high x 1 in. deep x 11/3 in. long. It provides readings from 000.0 to 359.9 deg with characters 1/8-in. tall. Numerals are engraved on dull black counter wheels and are filled with a brilliant, flat-white pigment. Each numeral on the tenths counter wheel provides increasing or decreasing readings of 1/10 deg, but a vernier scale on the right edge of this wheel permits accurate reading in increments of 3 min. One revolution of the input shaft provides one revolution of the tenths wheel and 1 deg of angular change. Counter is designed for continuous operation at 200 rpm. Unit shown has a right-hand shaft extension. Use of aluminum in the frame,



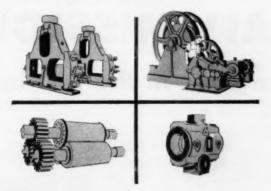
(Please turn to Page 292)



SERVICE FOUNDRY

Chances are that you have us in mind as specialists in marine components and sugar machinery. It's a fact that our reputation was built on serving these fields, and we continue to do a large volume in them. What we would like to tell you is that we've expanded our facilities over the years to the point of extreme capability in electric furnace steel castings of medium and high carbon content, semi-steels in our iron foundry, and aluminum, monel and the various alloys of brass and bronze in our non-ferrous foundry. Our machine shop is equipped with some of the largest and most diversified tools in the South—rounding out our complete foundry facilities.

Service Foundry would like to work for you. Your inquiry will bring a prompt, definite reply.

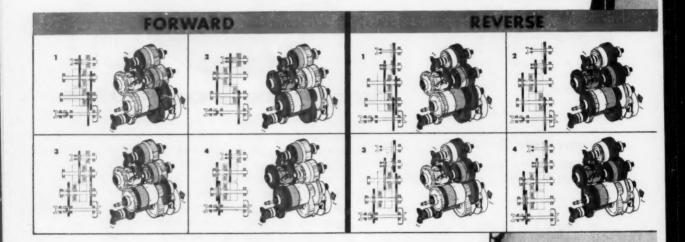




SERVICE FOUNDRY

416 ERATO ST. JACKSON 2-3836 NEW ORLEANS 13, U.S.A. a division of AVONDALE SHIPYARDS, INC.

4 Speeds Forward...4 Speeds Reverse FULL POWER SHIFT IN ALL RATIOS



New TWIN DISC TRANSMISSION

for engines in the 100 hp range

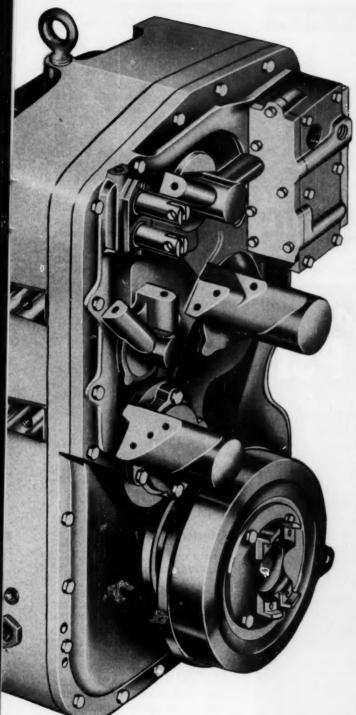
The Twin Disc "engine to axle" concept in OEM power transmission components takes another giant step forward with the introduction of the Series TD-44-400 Power-Sift Transmission. This new Twin Disc design is a four speed forward, four speed reverse box with full power-shifting in all speeds. Designed for engines developing from 75 net hp at 1800 rpm up to 108 net hp at 3000 rpm,* Series TD-44-400 includes two models

*This is rated horsepower delivery after power is taken off for auxiliary drives.

with an over-all ratio coverage of 6.91:1. Model TD-44-403 has ratios of 4.89, 3.19, 1.08 and .705; Model TD-44-404 has ratios of 5.98, 3.92, 1.32 and .866.

Simple design, positive operation

The complexities of planetary designs are avoided in the transmission's simple countershaft arrangement. Multiple-disc oil-actuated clutches energize the constant-mesh spur gear trains, while speed changes are effected by two



duplex clutches that function as range clutches.

Two large single-plate clutches handle the directionchanging job. These clutches, oil-cooled for maximum heat dissipation, act as the energizing clutches for all engagements.

Shockless clutching

Clutches are engaged by means of a cascade system of oil pressure regulation. A controlled pressure rise valve increases the pressure steadily and rapidly. This patented feature makes for exceptionally smooth clutch engagement.

The brake-regulated clutch release valve is ported for direct connection to the vehicle's brake fluid system. Thus, by depressing the brake pedal, the operator releases all cutches in the transmission, instantly cutting off the power source for vehicle movement.

Both ends of the output shaft feature yoke-type Ujoint connecting members as standard equipment. Also standard is a parking brake and a disconnect jaw clutch on the output shaft. This jaw clutch may be engaged for four wheel drive or disengaged for single axle drive,

Easy servicing

In designing the Series TD-44-400 Transmission, Twin Disc engineers have made easy servicing a prime requisite. Removal of the main housing cover gives complete access to all clutches and range gears. Anti-friction bearings are used throughout. The simple power train and relatively few parts can be readily appreciated when contrasted with the complex power flow and multiplicity of parts in a planetary gear transmission.

Torque converter-transmission package

The TD-44-400 Transmission is normally furnished with a Twin Disc Single-Stage Torque Converter as a package unit. The converter is a sumpless model featuring two power take-offs points. One is normally used for power steering. The other incorporates an SAE "C" pump mounting suitable for hydraulic power pumps.

Series TD-44-400 is one of a complete line of converter-transmission packages being developed at Twin Disc's Transmission Division. Twin Disc engineers will

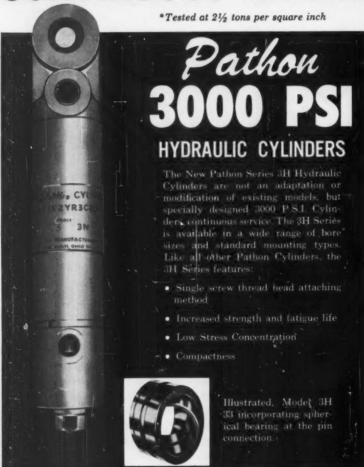
be pleased to make recommendations for these units in your vehicle drive. Contact the Transmission Application Engineering Department at our Racine office.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin; Hydraulic Division, Rockford, Illinois.



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3823 PACIFIC AVE., CINCINNATI 12, OHIO

FLUID OPERATED AND CONTROL EQUIPMENT

NEW PARTS AND MATERIALS

(Continued from Page 289)

counting wheels, and mask makes unit lightweight. Bowmar Instrument Corp., 8000 Bluffton Rd., Fort Wayne, Ind.

Circle 659 on Page 19

Rotary Actuator

produces 6.5 lb-in. torque at 120 psig

Miniaturized, high-speed, pneumatic rotary actuator completes a 90-deg stroke within 30 to 40 millisec. Designated Series 50, it fits a $1\frac{1}{2}$ x 2-in. package, and requires 0.16 cu in. of air to displace its piston. Action on the output shaft



is direct; torque produced at 120 psig is 6.5 lb-in. All moving parts are enclosed. Prototype quantities of the units are immediately available. Ledex Inc., 123 Webster St., Dayton 2, Ohio.

Circle 660 on Page 19

Actuator Motor

small unit has speed of 270-280 rpm

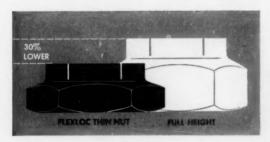
New 1-in. diam motor, complete with gear train, is $2\frac{1}{2}$ in. long and weighs 4 oz. It operates to 1000 hr. without maintenance, and meets requirement of MIL-M-8609 (ASG) for humidity, vibration, salt spray, and other environmental conditions. Gear reductions and armature windings can be varied to provide specific torques and speeds. Available in





SMALL WONDER: FLEXLOC THIN NUT

30% lower and lighter, yet still stays put for keeps!



Frequently you need a smaller, lighter locknut, yet you can't afford to sacrifice one whit of holding power. That's where self-locking Flexloc thin nuts come in.

Since they are 30% lower than full height locknuts of the same diameter, Flexloc thin nuts allow you to design more compact bolted joints. They often fit into space where clearance is insufficient for standard height nuts. Also, thanks to minimum projection, they improve appearance and increase safety.

And FLEXLoc thin nuts save precious weight—they themselves are 30% lighter and you save additional weight by using shorter bolts or studs.

What about reliability? FLEXLOC thin nuts won't budge, even in the face of impact or vibration. This is because every thread, including those in the locking section, carries its full share of the tensile load.

FLEXLOC thin nuts also . . .



- Simplify design—1-piece fasteners (no auxiliary locking elements required)
- Save production time—fewer turns needed to seat
- Lock without seating—serve as stopnuts as well as locknuts
- · Can be readily removed and repeatedly reused
- · Available in stainless as well as alloy steel

FLEXLOC thin nuts come in sizes from #6 to 1½ in. For complete information, see your authorized SPS distributor or write Standard Pressed Steel Co. — manufacturers of precision threaded fasteners and allied products in many metals, including titanium—for Bulletin 2339. INDUSTRIAL FASTENER Division, SPS, JENKINTOWN 18, PENNSYLVANIA.



where reliability replaces probability

The quickest most practical way to put strong threads in soft materials

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SLOTTED

IN SOFTER METALS AND PLASTICS... Has full V-form external threads to provide maximum locking torque and permit wide choice of mating hole sizes. Recommended for soft aluminum, zinc die castings, sand castings and plastics. Meets requirements of MIL-MS-35914.



H-SERIES

FOR HIGHER STRENGTH MA-TERIALS... Has heavy wall and truncated root external thread and three-hole culting edges for hard-to-tan higher-strength materials and to meet MIL and other specs calling for Class 3B thread fit for gaging after installation.



D. SEGIE

FOR SPARK PLUG SOCKETS
... Designed to eliminate thread wear and renew damaged threads in spark plug sockets in aluminum cylinder heads. Available from stock for standard plug sizes to meet most common needs.



W-SERIE

FOR WOOD ... Has coarse pitch external threads offering maximum strength in combination with ability to be driven into thin sections without splitting them. For furniture, cabinets and other wooden parts where strong, permanent threads are needed, or that are frequently as embled and disassembled.



Another fastener development from -

TAP-LOK GROOV-PIN

1130 Hendric's Causeway, Ridgefield, N. J.

Circle 377 on Page 19

NEW PARTS AND MATERIALS

either P.M. or reversible series, motor operates over an ambient temperature range of -65 to +250 F from an input voltage of 24-29 v dc. Speed is 270-280 rpm, with normal rated load of 13 oz-in. E.estro-Actuators Div., Omega Precision Inc., 757 N. Coney Ave., Azusa, Calif.

Circle 661 on Page 19

Air-Pressure Regulator

is accurate below I psig

Precision pressure regulator is available for air gaging, laboratory use, precision pilot air regulation, and other applications where exact accuracy and high sensitivity are required. Type 20AS precision pressure regulator is accurate at pressures below 1 psig. Regulator reduces line pressures of 0 to 150 psig to secondary pressures of 0 to 60 psig, and it is used over a tem-



perature range of 32 to 160 F. Made for ½-in. pipe, régulator provides accurate pressure control up to the maximum air flow recommended for this size pipe. Unit operates with freedom from hunt, hum, and chatter, and has built-in relief. It features exact repeatability and freedom from drift over short or long periods of time. C. A. Norgren Co., 3400 S. Elati St., Englewood, Colo.

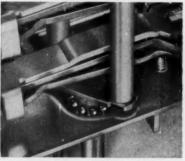
Circle 662 on Page 19

Hydraulic Swivel

incorporates all-metallic seals

New swivel withstands the high pressure and corrosive properties of aircraft and missile hydraulic fluids. Highly pressurized hydraulic fluids passing through the active swivel are locked in by metallic seals engineered for balanced hydraulic load-





To uphold its redoubtable reputation as a communications specialist, a leading manufacturer of automotive radio systems must be certain that every component used in its assemblies performs reliably.

For example, when this auto tuner assembly is coupled to the electrical system, it must provide positive location and low torque to ensure fine tuning ... and dependable, precision-quality bearing balls perform a vital function. The bearing balls provide uniform torque between the conical shaft and the bearing race, without introducing tortional strain and undesirable angular displacement ... and customer requirements for life expectancy and non-degradation in function of the complete assembly are repeatedly satisfied.

Abbott precision-quality bearing balls adapt easily, perform reliably, and last! A wide range of sizes is available. Write for complete information.



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A NEW ADDITION TO THE

SONAC LINE

POSITIVE

ULTRASONIC

LEVEL

CONTROL

Now, two new ultrasonic sensors, especially for level control have been added to the Delavan line of sonac sensing and switching devices.

The single sensor system is recommended for liquid level control and the double sensor system for dry level control.

Control is maintained by installing the SONAC sensor through the wall of the vat, bin or hopper. When the oscillation on the face of the sensor is dampened or impeded by the material being sensed, the signal to the control unit changes, activating a relay.







FIG. 2-DRY LEVEL (Two Sensors)

For level control, sonac is accurate to .005" and has a response time of 25 milliseconds. Performance of the sensor does not deteriorate with age.

The level control uses to which sonac can be applied are virtually unlimited. It is not affected by the viscosity*, specific gravity, conductivity, or capacitance of the material being sensed. Temperature or pressure changes of the material do not alter its performance. False signals are eliminated because sonac may be adjusted so as not to sense steam, foam, or vapors.

*Viscosity may affect response time.

Canadian Representative:

KNOWLES & FOSTER (North America) Ltd.

Circle 379 on Page 19

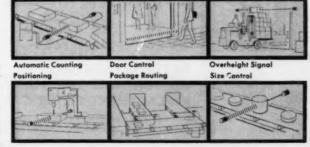
708 Terminal Bldg., Toronto 1, Ontario, Canada

Sonac is extremely rugged. Sensors are type 304 stainless steel. The electronic components in the sensors are hermetically sealed and will withstand pressures to 2000 psi and temperatures from -425° F. to $+450^{\circ}$ F. They are immune to shock, vibration or mechanical damage.

The components of Sonac (sensor actual Size)

The control is a compact unit 5" x 5" x 5" x 5" and features transistor circuitry. Power consumption is one watt and the unit will operate in temperature ranges from 40° F. to 135° F.

Here's how sonac can be used for sensing and switching applications other than level control.



There are dozens of applications for SONAC single and double sensor units. Let it go to work for you now, write:



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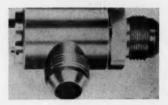
AT NO COST OR OBLIGATION, SEND ME THE ABOVE HYDRAULIC MANUAL

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COMPANY

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NEW PARTS AND MATERIALS



ing on metallic seats. Stainless-steel swivel performs effectively while handling hydraulic fluids such as Oronite and Skydrol under pressures to 6000 psi. Functional temperature ranges from a liquid nitrogen low to 650 F. Low-lubricity synthetic hydraulic fluids are sealed effectively over entire operatingtemperature range. Propulsion Development Laboratories Inc., 1120 E. El Segundo Blvd., El Segundo,

Circle 663 on Page 19

Washer-Base Nut

provides resilient tightening and locking action

Spring-tempered-steel integral acorn and washer-base nut is available either with notched locking form for threaded members, or with selfthreading form for use on unthreaded studs, rods, and wire. Unit assembles with standard tools, covers bolt ends, and provides resilient tightening and locking action. It is also available with integral sealer



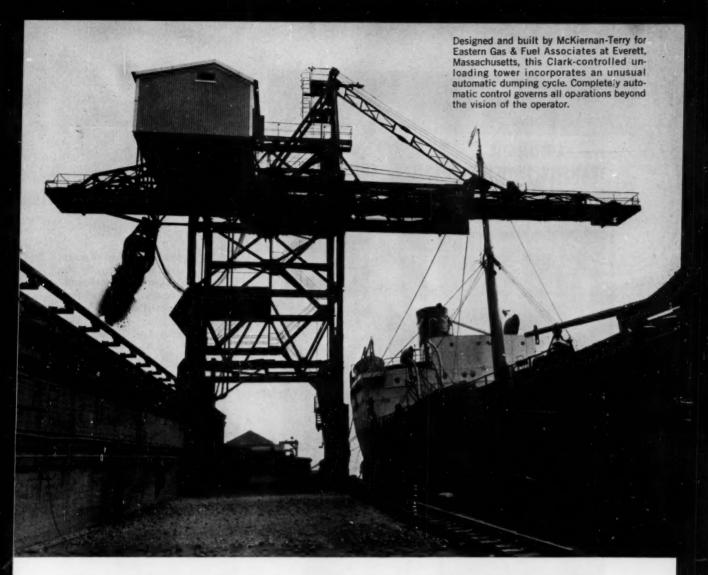
washer to keep out dirt and water. Palnut Co., Div., United-Carr Fastener Corp., Mountainside, N. J.

Circle 664 on Page 19

Fuel Filter

traps dirt particles as small as 0.002 in.

Adjustable plastic in-line fuel filter for small engines is corrosion resistant. Loosening of a screw permits the nipple to be turned to any



We gave a magic brain to this unloading tower

Building electrical controls to meet special requirements is a job for which Clark engineers are exceptionally well qualified. The Clark control system for this unloading tower, for example, features an automatic dumping cycle that is surer, smoother and faster than even the most skilled operator.

From his extendable cab overlooking the ship's hold, the operator fills the bucket and brings it up and back to the tower columns. The dumping cycle then becomes automatic and all motions are precisely controlled by Clark's unique "adjustable-in-motion" rotating cam limit switch. Trolley travel and bucket dumping are perfectly synchronized. The "plug" always is at the proper instant, followed by immediate return of the bucket to the front columns. Unloading becomes a continuous, flowing operation. A high free-digging rate is maintained with ease.

Working with men in industry to create equipment for better methods and greater economies is a job welcomed by our engineers. Just call the nearest Clark sales office or write:

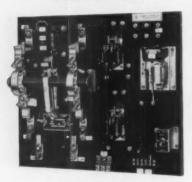


CONTROLLER COMPANY

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position around 360 deg. Removing the same screw permits the filter to be taken apart for cleaning. Unit does not reduce fuel flow while trapping dirt particles as small as 0,002 in. Tillotson Mfg. Co., 763 Berdan Ave., Toledo, Ohio.

Circle 665 on Page 19

Silver-Cadmium Cells

are sealed units in 0.1 to 300 amp-hr ranges

Sealed silver-cadmium Silcad cells meet power requirements of satellites, portable communications, and other electronic systems for maintenance-free operation, high capacity, and long life. Cells are available in ranges from 0.1 to 300 amphr. Energy output is 25-30 whr per lb and 1.6 whr per cu in. over a range of discharge rates. Yardney Electric Corp., 40-52 Leonard St., New York 13, N. Y.

Circle 666 on Page 19

Light-Indicator Modules

for use in the instrument and computer fields

Eight Weld-Pak light-indicator modules are available for applications in the instrument and computer fields. Each component within the rugged, potted module is welded for greater reliability and added compactness. Self-contained units need only external power supplies and trigger signals. Light indicators can be used for the vis-



Giant Radar Guards Our Shores...

ALEMITE OIL MIST WITH THERMO-AIRE GUARDS ITS GIANT BEARING!

The FPS-35 radar at Montauk Air Force Station, designed and developed by Sperry Gyroscope Company, is one of the largest in the world. The huge 140,000-pound antenna assembly rides on a precision-built azimuth bearing with an outside diameter of 160.500-inches. This bearing is machined to fit its retainer with a total looseness of no more than 0.006 of an inch.

10-years of continuous operation, with only four 24-hour shutdowns a year for servicing maintenance, is the life design-requirement for this antenna. For the all-important job of lubricating this azimuth bearing, Sperry Engineers selected Alemite Oil-Mist with Thermo-Aire. Oil-Mist provides the fully-automatic, continuous, all-over lubrication protection this bearing positively requires for trouble-free operation.

Oil-Mist with the new, exclusive Thermo-Aire enables Sperry's Engineers to eliminate guesswork lubrication assuring greater efficiency...longer bearing life. Oil-Mist is extra-clean; does away with drippings. Thermo-Aire permits atomization of the heaviest mineral oils and applies them automatically and continuously.

Find out how Alemite Oil-Mist can protect many of your designs against wear and breakdown. Write for free Oil-Mist catalog, or see your Alemite representative.



In Canada: Stewart-Warner Corporation of Canada Ltd., Belleville, Ontario

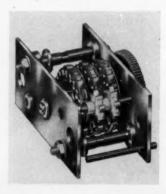
Dept. BB-51, 1850 Diversey Parkway, Chicago 14, Illinois

ual display of various signal levels and can indicate the state of specific information storage elements. Four of the modules employ transistor amplifiers and glow lamps. Two modules use transistors and incandescent lamps. One unit, the most sensitive of the modules, employs filamentary thyratrons. Another employs a cold-cathode thyratron. Industrial Components Div., Raytheon Co., 55 Chapel St., Newton 58, Mass.

Circle 667 on Page 19

Printing Counter

has count of up to 5000 per minute



High-speed, add-subtract printing counter is designed primarily for servo read-out. Basic counter has three digits; however, additional digits or decimal points can be incorporated as needed. Available with the counter are an automatic indexing mechanism, printing ribbon drives, and a printing solenoid. Counter printing speed is up to 5000 counts per minute, and starting torque is 0.05 oz-in. Standard character height is 3/16 in. with a spacing of 9/32 in. Radson Engineering Corp., Macon, Ill.

Circle 668 on Page 19

Water Pumps

of completely noncorrosive construction

Series W vane-type water pumps are for use in drink-vending machines, carbonators, and similar applications. Furnished in five different models, they have nominal capacities of 20, 40, 60, 80, and 100 gph, respectively, at 100 psi



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How to Punch Vulcanized Fibre to Reduce Fabrication Costs

by K. H. Alverson, Product Standards Director

Vulcanized Fibre's capacity for easy punching makes this material highly attractive to the designer whose application calls for characteristics such as good dielectric strength, light weight, rugged strength, irregular contours and holes and indentations in the surface of a part.

Punching is done with two kinds of precision: Rough punching uses the lowest cost solid dies, is rapid and economical, but leaves a fractured raw edge and is limited to stock thicknesses through 1/4 in.; smooth shaving uses a contour die ground to a sharp edge that slopes away at 45°. The edge shaves stock when the part is forced into the die producing smooth edges in parts up to 1 in. thick. Holes can be punched easily, but should be generally spaced from each other and from any edge by at least the thickness of the stock. Noncircular holes and counterbores should be made circular for machining when the stock thickness specified is too thick to punch.

For thickness under 3/64", vulcanized fibre can be punched most economically with steel rule dies. Dies for simple parts usually cost much less than solid dies even for irregular contours. Tooling for scoring or creasing can also be added with little additional cost.

Most parts can be punched without additional conditioning if the vulcanized fibre has its normal moisture content of 5½ to 7%. For especially difficult punchings, or for parts thicker than ½", heating up to 200°F may be desirable.

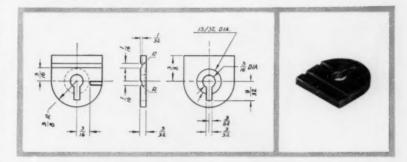
Additional economies may be obtained in thicknesses 1/16" and under by using coils slit from parent rolls, reducing waste of stock, speeding up the punching operation, and reducing inspection costs.

Many extras may be incorporated in punching operations on vulcanized fibre. These include scoring or creasing for subsequent forming along established lines. Also practical are swaging or forming into special shapes, such as shoulder bushings or angles.

Stamping letters and numerals into

the surface of vulcanized fibre in the punch-press operation produces permanently legible markings with no increase in cost of the part. White or colored roll leaf characters can also be impressed into the surface to give color contrast at very little added cost. Punched parts are also readily printed with rubber stamp.

Spaulding Engineers who have been trained in Value Analysis can help you take advantage of the wide range of possibilities in designing to reduce costs through the use of vulcanized fibre parts. They also make available to you Spaulding's extensive fabricating facilities and experience in working with this extraordinary material.



The fabrication of this shut-off switch insulator demonstrates vulcanized fibre's facility for punching and swaging. Previously moulded out of nylon, the part is now made by swaging both sides and punching vulcanized fibre — all in the same operation and at lower costs both for material and processing.

Send for your FREE copies of this literature



Value Analysis Brochure case histories of design improvement and cost reductions that have been accomplished through Spaulding's value analysis of customer products.

Vulcanized Fibre Engineering Data a design reference book which comprehensively covers all the application specs of vulcanized fibre.

SEE OUR DISPLAY AT THE DESIGN

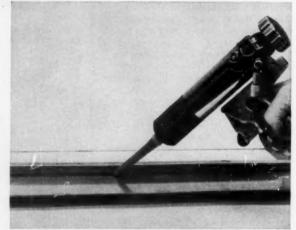


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Extrudable Handy Alumibraze "400" is ideal for brazing complex assemblies like these.

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differential pressure at speeds of 1725 rpm. Each model is available with or without built-in relief valve or built-in bypass valve, and with shaft modifications to suit drive arrangement. Of noncorrosive construction, units have carbon vanes, end plates and eccentric rings, and phenolic-ceramic face-type seals. Other parts are stainless steel or bronze. Tuthill Pump Co., Dept. WN, 939 E. 95th St., Chicago 19, Ill.

Circle 669 on Page 19

Microminiature Lamps

are 1/16 and 1/10 in. long

Two Pinlite microminiature incandescent lamps make possible a broad choice of physical and electrical characteristics. Type 13-7, 1/16 in. long, has a diameter of 1/64 in. It consumes only 0.0009 w at 1.35 v. Lamp response to pulsing at half-brightness is better than 4 millisec. Type 30-30, 1/10 in. long with 0.03-in. diam, provides approximately 250 millilumens output at 3 v. Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle 670 on Page 19

PVC Ball Valve

requires one-quarter turn to operate

Line of PVC valves and fittings now includes a type I (normal impact) PVC unit, Corrosion-resistant, low-





ADVANTAGES OF FLEXIBLE SHAFTING

For Power Drive and Remote Control

by
C. Hotchkiss, Jr.
Application Engineer

Stow Manufacturing Company

Flexible shafting has the following advantages over other type drives:

- 1—it is often the simplest method of transmitting power between two points which are not collinear or which have relative-motion
- 2—eliminates exposed revolving parts
- 3-does not require accurate alignment
- 4-easy to install and maintain

Not Collinear—Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a 1½-inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.



Fig. 1



Relative Motion — Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a 4-inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Co.



Fig. 2

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved—such as in vibration testing tables and concrete vibrators. Stow flexible shafts are available: for power drive applications in diameter sizes from ½-inch to 1½-inches; for remote control applications in diameter sizes from ½-inch to 1½-inches. The 1½-inch power drive shaft will transmit up to 10 HP while the 1%-inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering bulletin 570.

STOW MANUFACTURING CO...
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NEW PARTS AND MATERIALS

torque valve requires only a quarterturn to operate. It is available in sizes ½ through 4 in. in socket weld or threaded ends. Valve, which is virtually nonaging, features a rugged, compact body with external, one-end adjustment. Walworth Co., 750 Third Ave., New York 17, N. Y. Circle 671 on Page 19

Speed Reducers

in ratings from fractional to 58.5 hp

Fan-cooled helical worm-gear speed reducers are available in ratios extending approximately from 34.1 to 394.1. Seven sizes have 4 to 12-in. center distances, and ratings are



fractional to 58.5 hp. Helical primary gears are cut from high-hardness steel. In the secondary reduction, worms are machined from medium-carbon steel. Worm gears are cut from bronze of a high tincopper content, and are bolted or mechanically keyed to cast-iron hubs. On larger sizes, both primary and secondary gear trains share a common housing, while separate housings are used on 4 through 6-in. sizes. Cleveland Worm & Gear Div., Eaton Mfg. Co., 3300 E. 80th St., Cleveland 4, Ohio.

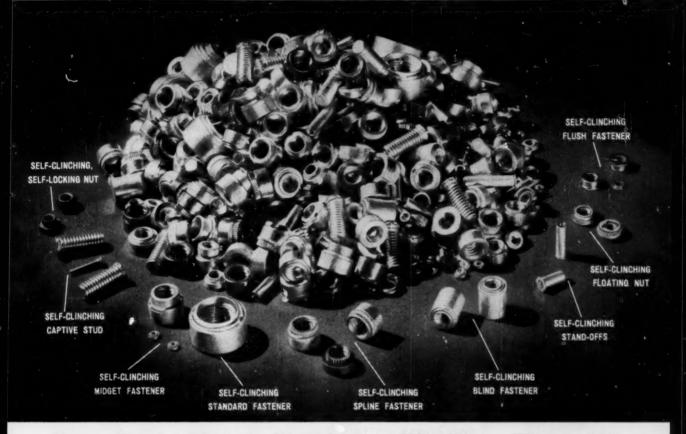
Circle 672 on Page 19

Insulated Thermostat

incorporates a bimetal actuated contact

Model DR miniature insulated thermostat can be calibrated and hermetically sealed at the factory or by the customer. Case is insulated by means of two glass-seal solder terminals. Unit incorporates a bimetal actuated contact. Internal construction is the same as that incorporated in other thermostats in

Gold Mine for Cutting Fastening Costs



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They are "installed by a squeeze, one or more at a time, with the greatest of ease" utilizing standard pneumatic or oil-hydraulic squeezers or mechanical presses.

The squeezing action embeds the head projections into the sheet—the displaced metal flowing smoothly and evenly around the back-tapered shank and annular groove to securely lock the fastener into the panel with

high torque and push-out resistance.

Used as standard equipment by the leading manufacturers of electronic, electrical and mechanical equipment, they are the solution of many particular engineering and production fastening problems.

Also, the diversification of products permits wide application of the same PEM self-clinching principle—providing one dependable source for all fastener needs.



Circle 390 on Page 19

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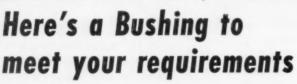
INDIANAPOLIS—CLIFFORD 1-402: DENVER—DUDLEY 8-4644 DETROIT—UNIVERSITY 3-5189 TOLEDO—GREENWOOD 4-9563 TORONTO—BELMONT 3-2161

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this line. Maximum differential is 0.5 deg C. Chatham Controls Corp., 156 River Rd., Chatham, N. J.

Large-Flange Rivet

for use in relatively soft materials

Large-flange Pop rivet of all-aluminum has a 3/16-in. diam mandrel and flange diameter of $\frac{5}{8}$ in. It is available for fastening applications involving relatively soft materials. Increase in flange size provides a correspondingly greater bearing strength. Rivets can be set from one side of the work when there is no access to the reverse side, employing a hand or power tool. Pop Rivet Div., United Shoe Machinery Corp., Shelton, Conn.

Circle 674 on Page 19

Sealed Bearings

operate continuously at 300 F temperature

Flexeal sealed bearings block out dirt and retain bearing lubricant while operating at high speeds in moderate to high temperatures. Bearings consist of a standard precision bearing with a rubbing seal of fiberaluminum laminate. Seal, installed in the shield groove of the bearing outer ring, seals against a ground surface on the bearing inner ring. Friction of the seal is negligible. Bearings have been operated to 3000 hr at 80,000 rpm without damage



or loss of efficiency. They have also tolerated lineal speeds of 6000 fpm. Operating temperatures range to 300 F for continuous operation. Ten unflanged and three flanged sizes from 0.3125 to 2.4409 in. OD are available. Barden Corp., 200 Park Ave., Danbury, Conn.

Circle 675 on Page 19

Impulse Counter

counts at up to 500 per minute

Series 311 Atcotrol impulse counter provides miniaturized count control with automatic reset, and counts at a rate up to 500 per minute. Features include built-in start button integral with count-setting knob;



either one or two SPDT snap-action 10 amp load switches; impulse-type motor with long life; nonreset upon power failure; four standard count ranges of 1 to 120, 2 to 240, 4 to 480, 8 to 960. Automatic Timing & Controls Inc., King of Prussia, Pa.

Circle 676 on Page 19

Switch Light

for application where two switching functions are needed

DPDT snap-action switch light, 6BR, has built-in lead-lag zeroing. Screw-driver adjustment, before or after installation, allows user to zero the switch at both poles for simultaneous switching. All components are contained in one compact, anodized-aluminum case. Unit is designed for application where two switching functions are required, combined with an independent but logically related lamp indication. Individual lamp and switch terminals are located in a rear turret arrangement. Color

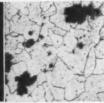




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Exclusive M-D 3-lobe design adds strength—reduces torsion. Dynamically balanced rotor permits higher speeds—greater pressures.



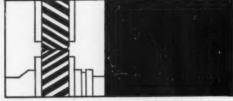


DUCTILE IRON

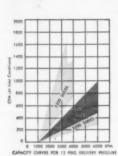
Only M-D uses ductile iron rotors. Only M-D rotors are cast with lobe and shaft integral—no pins to work loose. Makes M-D blowers safest at high speeds.



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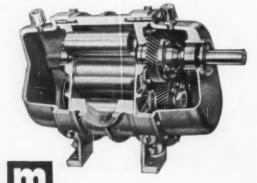


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M-D blowers operate at wider pressure and speed ranges than any other rotary positive blower. Capacities of 30 production models range from 30 to 4,000 CFM, pressures to 15 PSIG single, 70 PSIG multi-stage.



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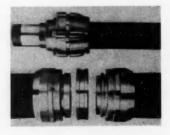
coding is provided by nonrotating pushbutton lenses in all standard clear or translucent colors. Snapon lenses provide both front and side illumination. Guaranteed for 25,000 operating cycles at 28 v dc with 7 amp resistive load, unit meets all applicable MIL specs. Lamps are standard two-pin, plugin units with operating voltages from 5 to 28 v dc. Eldema Corp., 1805 Belcroft, El Monte, Calif.

Circle 677 on Page 19

Hose Couplings

for use with wire-braided or spiral-wrapped hose

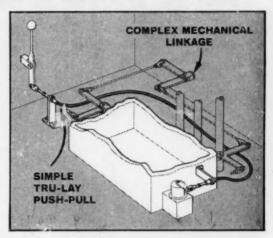
Reusable, high-pressure Power Grip hose couplings have positive mechanical grip, eliminate hose-end preparation, accommodate for all hose-wall thicknesses, and assemble with one standard wrench. Couplings are intended for use with wire-braided or spiral-wrapped hose. They consist of a nipple with two floating collars presenting internal cam surfaces to mating cam angles on the OD of a wedge circle. As tension is applied to the floating collars through tensioning screws, wedge is compressed at a 90-deg angle to the longitudinal axis, eliminating scarfing of the hose and uneven pretensioning of fabric or wire reinforcement. Wedge is designed to tighten under hose pressure and to prevent crimping of reinforcing wire. Couplings are available for



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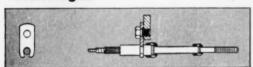
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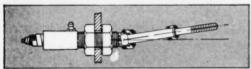


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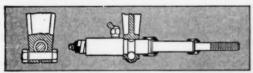
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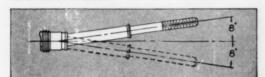


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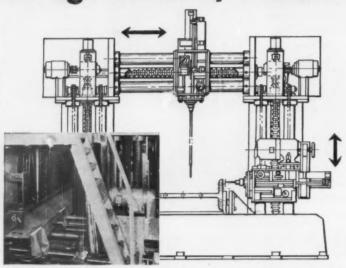
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Beaver Ball Screws help Mahon save 85% in drilling holes in bridge beams, columns



Close tolerance positioning of massive $1\frac{1}{2}$ " capacity vertical and horizontal drill heads is accomplished with Beaver ground-thread ball screws in this new, numerically controlled drilling machine, first in the structural steel industry.

Walter P. Hill, Inc., designed and built the machine for The R. C. Mahon Co., Structural Steel Division

In addition to the important drilling cost savings, it offers repeatability in hole pattern accuracy within $\pm .005''$ as compared with $\pm \frac{1}{8}''$ by conventional methods and eliminates costly hole reaming in final assembly.

If you are considering data control, Beaver ball screws will give you the power efficiency, positioning control and compactness you need. Our engineers will be glad to work with you just as they did, in this case, with the Walter P. Hill designers.



hoses having IDs from $1\frac{1}{2}$ to 12 in. Consolidated Controls Corp., P. O. Box 348, Annapolis, Md.

Circle 678 on Page 19

Solenoid Valves

control hydraulic systems at pressures to 2000 psi

Series X10 two and three-way, highpressure, explosionproof solenoid valves are for hydraulic-system applications in hazardous locations. Valves are stainless-steel, direct-acting, slide type, and control hydraulic systems at pressures to 2000 psi. They have a 3/32 in, inlet and



cylinder orifices with ½-in. NPT. Valves can be used as two-way normally open or normally closed, or as three-way normally closed, normally open, or as dual-purpose units. Skinner Electric Valve Div., Skinner Precision Industries Inc., New Britain, Conn.

Circle 679 on Page 19

Linear-Motion Potentiometers

incorporate two tracks of conductive plastic

Type 2986 dual-element, rectangular, linear-motion potentiometers are applicable in designs with space limitations and in high-performance, continuous-duty requirements. Resistance element embodies two electrically-isolated, solid raised tracks of conductive plastic integrally comolded, together with taps and terminals, to an insulator base of high-temperature phenolic resin of matched thermal expansion coefficient. Conductive plastic tracks afford virtually infinite resolution and long wear-life. Potentiometers also have low electrical noise and resist

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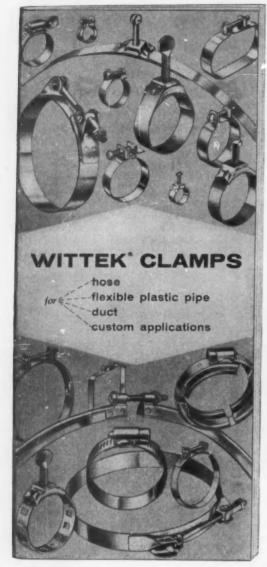


CHROMALOX ELECTRIC HEAT

PROCESS COMFORT

Visit Chromalox Booth #220 Design Engineering Show May 22-25

WHAT'S YOUR CLAMPING PROBLEM?



See us at the Design Engineering Show

Detroit, Michigan May 22-25

Booth No. 526

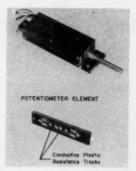
WITTEK has the answer...

Whatever your clamping problem, it's a safe bet that Wittek has the exact type and size clamp to do the job. Write for this new 16-page brochure on standard Wittek clamps and custom-made clamps.

Quality Clamps for Over 35 Years

WITTEK Manufacturing Co. 4349 West 24th Place, Chicago 23, Illinois





70g vibration at 5 to 2000 cps as well as shock loading in excess of 100g without malfunction. Offering independent linearities of ± 0.5 per cent or better, potentiometers are available with element resistances from 250 to 50,000 ohms. Shaft stroke is 1.3 in., electrical length is 1.0 in., and dielectric strength is 1500 v rms. Markite Corp., 155 Waverly Place, New York 14, N. Y.

Circle 680 on Page 19

Dry-Film Lubricant

resists temperatures from -120 to +500 F

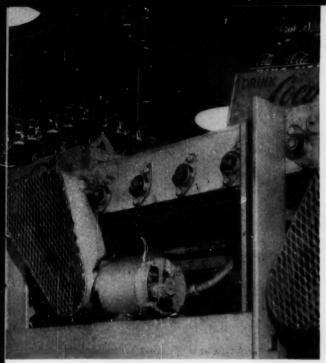
Dri-Lube dry-film lubricant and release agent, packaged in an aerosol container, contains a fluorocarbon dispersion which eliminates sticking, freezing, galling, slip-stick, and abrasion. It is completely inert to nearly all acids, alkalies, and solvents, and resists oil and water. Slick surface it provides remains through temperatures of -120 to +500 F. Lubricant is greaseless, does not collect dirt or dust, and is nonflammable. Fluoro-Plastics Inc., 2417 Federal St., Philadelphia 46, Pa.

Circle 681 on Page 19

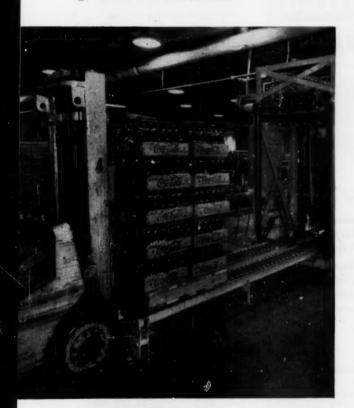
Diaphragm Pressure Switches

have standard body with interchangeable components

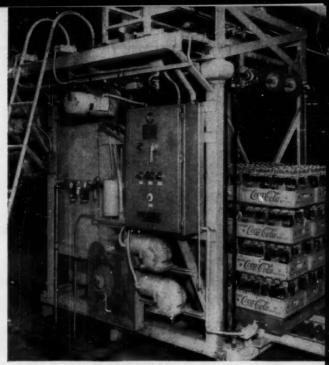
Line of diaphragm pressure switches provides accuracy of ± 0.5 per cent in standard models. Standard body is used, to which interchangeable components such as contact elements, capsules, terminal-block housings, and explosion-proof housings can be attached. Proof pressures to 600 psi and adjustable ranges from vacuum to 400 psi are available. Basic



Century's compact IR 48-frame gearmotor driving live roll conveyor to the top of pallet loader.



loaded pallets being picked up by lift truck. Century 1R66 SC66, 34 horsepower gearmotors drive empty and loaded pallet conveyors.



A Century 1R64 SC64 gearmotor with brake (in upper left of picture) raises and lowers pallets from empty pallet conveyor to loaded pallet conveyor.

Century gearmotors load, stack and convey thousands of soft drinks per day

Century Electric's single-reduction, right-angle gearmotors are built right into the versatile pallet loader shown here. Thousands of bottles of soft drinks a day are conveyed, stacked, loaded onto pallets and conveyed to fork lift trucks by Century's gearmotors.

Century gearmotors, with silicon bronze worm gears and hardened high-grade steel worms, are designed and built to withstand sudden shocks and overloads in applications such as this pallet loader. Motor shafts are not affected by operational strains because mounting feet are an integral part of the housing (except the IR 48-frame). Also, motor shafts are carried on ball bearings and output shafts run in tapered roller bearings to withstand sudden shocks.

All-angle oiling design assures complete lubrication. Worms or worm gears dip into oil, no matter how the gearmotors are mounted.

The gearhead on the IR 48-frame gearmotor (Picture No. 1) can be assembled in four different positions in relation to the motor, and the motor can be mounted at any angle. The new 1R 48-frame gearmotor is also very compact. With it you can reduce the weight of your product by as much as 20 pounds.

For more information about Century's complete gearmotor line from ½ to 125 horsepower, call your nearest Century Sales Office.

CENTURY ELECTRIC COMPANY

St. Louis 3, Missouri Offices and Stock Points in Principal Cities

Circle 398 on Page 19



EXCLUSIVE WITH CARTER! ROD SCRAPER PLUS ROD WIPER AS STANDARD

J. I. C.Interchangeable SQUARELINE Series features a Metal Rod Scraper plus a Rod Wiper in a quick change Cartridge—Double protection against chips, dirt, damage. Unitized cartridge rod bearing . . . easy removal and replacement . . . no cylinder disassembly necessary!



UARELINE 2000-3000 PSI HYDRAULIC

- 0 11/4" to 12" hore
- True cushion-automatic concentric alignment
- e 100% JIC interchangeable Positive piston locknut design
 - Delivery from stock!

COMPLETE LINE

ROUNDLINE AIR-HYDRAULIC



- Space saving designs! Light weight!
- Full 1 to 1 Meehanite cartridge red bearing.
- Precision honed heavy wall tubing-6 to 1 safety factor.
- Spring loaded "V" packing on rod end aland.
- Key type stainless steel locking ring. Allows 360° orientation of pipe ports.

TORQUE ACTUATOR NEUMATIC-HYDRAULIC

0-1000

0-190°

- New design opportunities
- * To 370° rotation as standard
- · Safe, powerful torque
- Air, oil, gas, water operation
- · Zero leakage

STANDARD ROTATIONS 0-280°

IMMEDIATE DELIVERY ON ALL STANDARD CYLINDERS AND ACTUATORS

0-370

D FOR MASTER CATALOG

Complete bound file. Air and hydraulic cylinders. Rotaries, clamp cylinders air valves, and the new SQUARELINE Camplete details and prices SEND TODAY



NEW PARTS AND MATERIALS



body forms a heavy protective capsule around the diaphragm, and permits the use of an almost unlimited variety of diaphragm metais and thicknesses. Standard pressure connection is 1/4 in. NPT female pipe fitting. Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 682 on Page 19

Ribbon Cable

has wires bonded together

Westrip multicolored ribbon cable consists of plastic insulated wires bonded together to form a flat, ribbonlike cable. Strip is manufactured to military and commercial specifications, in Sizes No. 28 through No. 10, up to 1 in, wide and up to twenty conductors. Westwood Cable Corp., 3440 Overland Ave., Los Angeles 34, Calif.

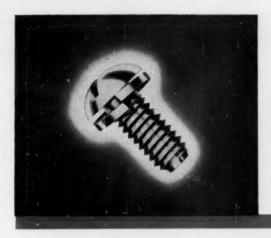
Circle 683 on Page 19

Servo Motor-Brake Unit

is controlled by an electromagnet

New unit consists of a size 11 servo motor with an integral friction brake controlled by an electromagnet. Brake effectively stops and holds the rotor of the motor at a desired position, preventing it from turning or creeping under high vibration or shock. Friction brake



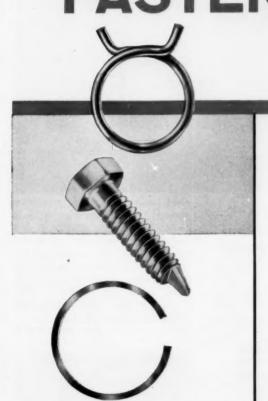






FASTENERS

unseen muscles in assembled products



Because the initial cost of a fastener represents only a minor part of the total cost of "using" it in an assembly, the bulk of your fastener savings will come from these features: engineering assistance to insure use of proper fastener, ease of handling on the assembly line, stock availability and service. Metal quality, strength, vibration resistance, durability and manufacturer's reputation are also important parts of your "fastener package."

You can get all of these things by specifying Eaton-Reliance fasteners. They've been used by manufacturers of assembled products for almost half a century.

Write for our new 16 page full line catalog containing complete information.



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- RELIANCE DIVISION

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SALES OFFICES: New York . Cleveland . Detroit . Chicago . St. Louis . San Francisco . Los Angeles

Which coupling cuts costs?

All of Waldron's many types will reduce maintenance and operating costs, and Waldron's engineers will help you specify the best one for your power transmission, whether the drive is big or small.

Bore	Max. torque inch-pounds	Max. rpm
½ to 7½	716,310	12,000
5% to 10½	567,000	4,000
1/2 to 2	2,200	5,000
3/8 to 3/4	100	10,000
½ to 8	1,197,000	70,000
½ to 25/8	5,200	3,000
% to 25%	17,500	2,400
4 to 13	2,520,000 5,000,000	St'd 2,000 Forged 4,000
1 to 6	400,000	6,500
	1/2 to 71/2 5/8 to 101/2 1/2 to 2 3/8 to 3/4 1/2 to 8 1/2 to 25/8 5/8 to 25/8 4 to 13	## inch-pounds ## 1/2 to 71/2

This is merely a sample of the Waldron line, which also includes mill motor, floating shaft, Jordan, shear pin, vertical, spacer, oil collector, marine, brake wheel, and continuous lubrication types. Write for catalog or data sheets on the types you are considering.

WALDRON



WALDRON-HARTIC, Box 791, New Brunswick, N. J. a division of Midland-Ross Corporation



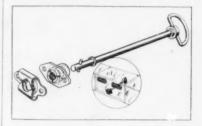
NEW PARTS AND MATERIALS

is energized by means of a spring; it is disengaged, to allow the motor to run, by means of an electromagnet energized by 24 v dc. Braking time is 8 rpm maximum, measured from a no-load speed of 6200 rpm. Motor operates on 115/115 v, 400 cycles. Instrument Div., Thomas A. Edison Industries, McGraw-Edison Co., West Orange, N. J.

Circle 684 on Page 19

Module Fastener

for multiple-pin connectors



Easy engagement and disengagement of module to rack and positive lock of multiple-pin connectors are provided by a new rapid-traverse fastener. Assembly is composed of a variable-length stud shank, a nylon guide bushing, and a standard quarter-turn Airloc receptacle. When cross-pin on stud shank travels 11/4 turns through guide bushing, steady, even pressure is exerted laterally across the connector. An extra 1/4 turn locks cross-pin in receptacle, securing module in rack and firmly engaging connector. Module slides out smoothly by 11/2 turns of stud. Fastener is available in required stud-shank length with wing, swivel ring, knob, or screwdriver-slot stud head. Monadnock Mills, San Leandro, Calif.

Circle 685 on Page 19

Air-Hydraulic Cylinder

for machine-tool and automation applications

CLH stud-mount, double-acting or spring-return, clamp-type, heavy-duty air or hydraulic cylinder is available for compact machine-tool and automation applications. Cylinder is 15/8 in. square, with short over-all length, and weighs 2 lb in 1-in. stroke size. It accommodates pressures of 250 psi air and 1500



"Spring Action" gives you a leakproof seal with J-M spirotallic® gaskets

Johns-Manville makes a specialty of building a lively "spring action" into Spirotallic Gaskets. Because of their superior resiliency, Spirotallic Gaskets can compensate for varying stresses and temperature changes



Examples of wide range of styles available

... follow minor flange separation ... and absorb vibration. Even under these difficult circumstances, they keep a tight, durable seal.

This quick adaptability has given Spirotallic Gaskets a tremendous popularity in the field. Their springiness is due to the special methods and control J-M uses in their manufacture. Spring-like metal strips, formed into a special vee shape, are alternately spiral-wound with an as-bestos filler. The filler does the seal-ing . . . and the vee shape provides the "spring."

Another reason for the widespread acceptance of Spirotallic Gaskets is the fact that when the gasket has been compressed the proper amount, it reaches optimum performance for the bolting. Many different metals and fillers can be used. Each metal is color-coded to aid maintenance personnel in quick identification of the type of metal

J-M produces a wide variety of sizes and shapes for standard flanges. And for special flanges, J-M will design and produce a gasket with the precise characteristics you require. For complete information, ask for J-M catalog PK-35A. Write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JM



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RELIABILITY

Spring power eliminates dependence on electrical power source. The mainspring is made from a new, super-tough special steel alloy, which virtually eliminates failure, and is UNBREAKABLE.

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Our timing devices are designed to ring bells, flash lights, turn valves, pull release pins, cut cords, open containers, and start, stop or operate electrical or mechanical equipment.

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. . . and many others

Lighting equipment

H. RHODES Hartford 6, Connecticut

In Canada M. H. Rhodes (Canada) Ltd.



Plan to visit Booth 162 at the Design Engineering Show

NEW PARTS AND MATERIALS



psi hydraulic, and is available in 1, 2, and 3-in. stroke size. Sheffer Corp., 326 W. Wyoming Ave., Cincinnati 15, Ohio.

Circle 686 on Page 19

Aluminum Pulley Stock

1/5-in. pitch stock in 8-in. lengths

Designed particularly for model shops, research and development departments, and for firms which require timing belt drives but cannot use the regular standard sizes, 1/5-in. pitch aluminum pulley stock is available in 8-in. lengths for use with U.S. timing belts. Pulley stock can be cut down to any size desired. Number of grooves on the stock varies from 10 to 36 and the pitch diameter is available in sizes from 0.637 to 2.292 in. H. Neuman & Co., 8136 N. Lawndale Ave., Sokokie, Ill.

Circle 687 on Page 19

RF Connectors

subminiature units in snap or screw-on types

ConheX crimp-type design is available in both screw-on and snap-on subminiature RF connectors, Crimptype design permits the assembly of three cable connectors in the usual time for a single one assembled by the conventional manner. Crimptype employs a sleeve which is slipped over the cable. Cable is then trimmed, and center conductor is tinned and inserted into the connector body. Sleeve is slipped up





A Tinnerman T-Marked Original ...

Dual SPEED NUTS® open door to 20% savings on as-assembled cost

Gibson refrigerator door hinges are held in place with new cost-cutting, time-saving twin-type SPEED NUTS. They replace \%_16" plate hinge retainers which had to be drilled and tapped for machine screws.

Gibson Refrigerator analysts estimate that special twin-type SPEED NUTS save 14% on the cost of each hinge retainer assembly, 20.5% on the as-assembled cost. Labor is reduced by half. Former problems with cross-threading and stripping are eliminated... SPEED NUTS and A-type screws go together naturally every time—and faster!

The T-mark of quality and dependability identifies the more than 10,000 variations of Speed Nut brand fasteners. From this unlimited selection come many saving opportunities for you. Ask your Tinnerman representative to arrange for a free Fastening Analysis of your product. An engineering service that may produce similar savings for you.

You'll find Tinnerman under Fasteners in your Sweet's Product Design File and in the "Yellow Pages." Tinnerman Products, Inc., Dept. 12, Box 6688, Cleveland 1, Ohio.



OTHER T-MARKED SPECIALS



SPECIAL "J" SPEED NUT cuts production time in half for a major gas range manufacturer. Simplified right-angle panel or brace attachments for a variety of appliance, cabinet, and instrument applications. Live-spring tension means a vibration-proof grip.



SNAP-IN FIXTURE FASTENER developed specially for Imperial Lighting Products Co., trimmed 80% off lighting fixture assembly time. Once fastened to the ceramic socket, this unique SPEED NUT snaps quickly into the fixture base...replaces three parts.



PUSH-ON SPEED NUT anchors latching bars on steel desks, reduces material and assembly costs by 50%. Push-on Speed NUTS can be attached on studs, rivets, or tubing in a split second, and eliminates need for threaded parts...saves time and money.

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Simmonds GMBH, Heidelberg.

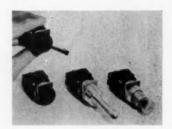
against the connector body, and crimped with a hand or power tool of the proper design, after which the contact is soldered to the center conductor. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N. Y.

Circle 688 on Page 19

Miniature Pushbuttons

are available in four new forms

Miniature, oil-tight, industrial pushbuttons now include a wobble-stick operator, bat-lever selector switch, coin-operated selector switch, and cylinder-lock selector switch. Separable operators, contact blocks, rings, selector-switch knobs, illuminated forms, and color caps are offered to give the extra flexibility



of building - block construction. Small, basic number of operators and blocks will provide a wide variety of different combinations. Rings, buttons, and selector-switch knobs are available in a tough plastic that provides maximum flexibility in color coding, color permanence, and attractiveness. General Electric Co., Schenectady 5, N. Y.

Pinch Valve

is positive-opening type, even at low pressures

Series L positive-opening pinch valve permits straight-through flow in either direction at up to 98 per cent of full-line flow capacity. Design assures complete opening of the valve, even when line operating pressure is below 10 psig. Valve is recommended for process control, tank drain valves, vacuum service, for placing on the suction side of pumps, and for corrosive, abrasive, or viscous fluids, and for dry powders. It is available in sizes from 1/4 to 14 in. ID for a maximum



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PRODUCT-DESIGN BRIEFS FROM DUREZ

- · Phenolic for pumps
- Dip-coating compounds
- Plastic process equipment



FLINT & WALLING MFG. CO., INC.

Why not?

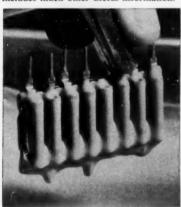
Here's a good way to engineer more profit into a pump.

The impeller is phenolic. It won't rust or corrode; it defies stubbornly the onslaughts of acid, oil, alkali, and soap.

A cubic inch of molded phenolic costs much less than you'd allow for a more traditional impeller material. Forget about machining; phenolic parts seldom need any.

If a pump must handle liquids as hot as 300°F, don't let that stop you from specifying phenolic.

We can work with your molder on the application you have in mind. Why not write us about it? Or simply check the coupon for Bulletin D400. It lists the properties of a typical Durez phenolic molding compound used in pumps, and includes much other useful information.



Coat for components

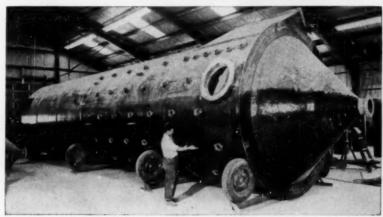
Looking for a simple encapsulating idea? Here's one that works well at heatproofing, moisture-proofing, and preventing shorts in small electrical components. It's non-messy, too.

Dunked in a paste coating, dried, then baked for a short time, components steadfastly resist extremes of heat and moisture that would otherwise raise havoc with their electrical reliability.

Components so coated can be soldered into a circuit without causing the coating to melt or peel. It won't soften, and easily passes a series of -55 to +85°C cycles. One thousand hours at a sweltering 150°C will turn the coating almost black but still won't materially affect the component inside.

The paste is made with Durez phenolic resin-and-filler compounds supplied in powder form. There's a choice of densities and toughnesses. One type is impervious to ketone solvent cements sometimes used in assembling radio and TV chassis.

What can these dip-coating compounds do for you? We'd like to help you find out. Write for more detailed information.



FABRICATOR: DP VERRE, INC., ARCADE, N.Y.

What's your big idea?

Think big. A 50-foot plastic boat...a 150-foot plastic radome... or a plastic chemical scrubber like this behemoth designed and sold by Buffalo Forge Co.—all are actualities today, with an assist from glass-reinforced Hetron® polyester resin.

The scrubber is expected to save someone a lot of money. In corrosive situations, Hetron has repeatedly proved it can outlast other commonly used materials by a factor of two, three, or more. First cost can be as low as one-third that of other special corrosion-resistant materials. There's one other important point: safety. Hetron is inherently self-extinguishing. It retards fire because of its unique molecular configuration. Often, a Hetron installation—whether it's ducts, fume hoods, tanks, stacks, or blowers—can obviate the need for a sprinkler system.

If you'd like to know what the processequipment fabricators are doing nowadays with this versatile, safe polyester, use the coupon. We'll gladly send you a data file on Hetron, including a list of leading fabricators who can shape it to your specifications.

For more information on Durez materials mentioned above, check here:
☐ Phenolic molding compounds (8-page Bulletin D400)
☐ "Phenolic Resin Compounds for Dip-Coating"
☐ Hetron polyester resin (data file and list of fabricators)

 "Durez Plastics News" (a review of current plastic applications, mailed bimonthly)

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It's practical and economical to produce oddshaped parts on a Fellows Gear Shaper.

Merely by using special cutters and fixtures on standard Fellows machines, an almost limitless variety of internal and external contours can be generated. In many cases, a single set-up does what ordinarily would require several conventional shop operations,

And, of course, standard Fellows generating equipment also provides high production of internal and external spur and helical gears, from "miniatures" up to 120 inches OD.

This versatile production method is fully described and illustrated in "The Art of Generating with a Reciprocating Tool." Send for your free copy of this informative booklet.

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THE PRECISION LINE Gear Production Equipment



operating pressure of 400 psig, and can be furnished for hand, air, electrical, or electrohydraulic operation. Valve body can be any commercially available elastomer. It is used to protect metal body flanges. RKL Controls Inc., Hainesport, N. J.

Circle 690 on Page 19

Digital Readout

has quick-disconnect terminal unit

Series 120000 miniature digital readout incorporates a quick-disconnect unit which contains twelve terminals ready for wiring. Two protruding spring-type arms, when pressed together between the fingers, quickly release the terminal assembly from the readout itself, making possible the stacking of readout units and allowing free access to lamps at the rear of the readout. Readout is 1 in. wide, 1 5/16 in.



high, and 3 15/16 in. long. Industrial Electronic Engineers Inc., 5528 Vineland Ave., North Hollywood, Calif.

Circle 691 on Page 19

Tube-Pipe Nipple Fittings

permit fitting in close quarters

Difficult piping layout and maintenance problems can be solved with O-Ring Seal fitting in combination with Tube-Pipe Nipples. Photo-



CAUSTIC

A CASE IN POINT—This is a 19 pound Ni-Resist valve body designed to handle caustic fluids at 400 psi. It was cast for the John Bean Division of Food Machinery & Chemical Corp. Ni-Resist is ideal for this application because it combines high corrosion resistance with superior resistance to erosion from high velocity fluids.

The intricate coring required demands unusual skill to produce Ni-Resist castings leak-proof at 400 psi operating pressures. Hamilton Foundry succeeded in producing pressure tight castings, an accomplishment difficult for the best of foundrymen.

When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules—will be met.

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. West Airis Colonial Kolonite Co.

NEW PARTS AND MATERIALS



graph shows an example of this use. Outlets are too close to permit screwing male elbows into the ports, but use of the combination permits installation with minimum space between the elbows. Tube-Pipe Nipple fittings are available in a full range of sizes from ½ to 2 in. OD tube. Lenz Co., 3301 Klepinger Rd., Dayton 1, Ohio.

Circle 692 on Page 19

Bimetal Disc Thermostats

have rapid response characteristics

Types A and AY snap-acting, fixed-temperature thermostats, for use in appliances and industrial apparatus, feature quick make and break of the circuit. Bimetal sensing disc can be either enclosed or exposed, according to the application. Screw, solder, spade, formed, or elevated terminals are available. A variety of mounting provisions can also be supplied. According to the model, Types A and AY thermostats are supplied in many ranges, tolerances,



and differentials for operation from -20 to +300 F. Stevens Mfg. Co. Inc., P. O. Box 1007, Mansfield, Ohio.

Circle 693 on Page 19

Torque-Arm Reducer

shaft-mounted unit develops high torque

Size 17 Torque-Arm single-reduction unit with 5:1 gear ratio transmits high horsepower at output speeds shortest distance between you and RELIABILITY!



INDUSTRIAL TIMER CORPORATION

RELAYS

FOR EVERY APPLICATION

Factory Tested for Reliability!

GENERAL PURPOSE Open Type Relay. Up to 3PDT, 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin 10.



GENERAL PURPOSE Plug-In Type Relay. Contact arrangements up to 3PDT. 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin 10.

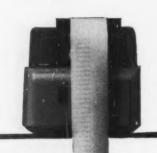


PRINTED CIRCUIT Open Type Relay. Up to 3PDT. 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin 11.





211 River Street, Orange, N. J.
Industrial Relays, Foot Switches, Buzzers, Coils
Phone: ORange 2-8200



IT ALL Adds up To this...

YOU CAN'T BUY SURE-FLEX PERFORMANCE IN ANY OTHER COUPLING AT TWICE THE PRICE

Wood's Sure-Flex Couplings not only have full, 4-way flexing action, but absorb from 5 to 15 times more shock and vibration than other leading flexible couplings. They swallow all types and combinations of angular and parallel misalignment and end float. Sure-Flex couplings are simple, easy to install. Standard models have only 4 basic parts. . no bolts, nuts, screws, clamps or covers. And, they last endlessly (61/4 million 15° peak torque flexes with no sign of wear). There's no metal-tometal contact, no wear, no need for lubrication. Available in capacities up to 500 hp at unity service factor . . . in standard, junior, bushed and spacer types. There's a lot more to tell about Sure-Flex.

DON'T MISS BOOTH 901 AT THE DESIGN ENGINEERING SHOW



Write for BULLETIN 5103.

T. B. WOOD'S SONS COMPANY - CHAMBERSBURG, PENNSYLVANIA

SF/2361

ATLANTA . CAMBRIDGE . CHICAGO . CLEVELAND . DALLAS



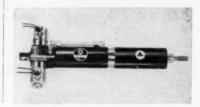
to 400 rpm. Unit develops high torque, and accommodates 60-hp motors in the top range of output speeds based on Class 1 AGMA ratings. Reducer can be applied to equipment operating in the speed range above 15:1 and 25:1 double-reduction reducers, and in the horse-power range designed to accommodate motors to 40 hp. It is available for horizontal shafts, but can be obtained also for vertical or inclined shafts. Dodge Mfg. Corp., Mishawaka, Ind.

Circle 694 on Page 19

Tandem Cylinders

in $1\frac{1}{2}$ to 4 in. bore sizes and lengths to 80 in.

Type BVT units consist of a valvein-head cylinder and a double-acting cylinder, mounted in line and featuring a common head at the center and two separate pistons mounted on one solid rod. Cylinders are available in bore sizes of $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3 and 4 in., in lengths to 80 in. Choice of mounts is offered, as well as a choice of 48 different models of valve-in-head cylinders for the power section. Rods are stainless steel, and brass or steel tubes are treated for corrosion. Units combine the advantages of valve-inhead cylinders with the advantages of hydraulic control of an air-operated cylinder. Airspeed controls are provided in the valve section of the valve-in-head cylinders, and hydraulic speed control is obtained





from machine tools to typewriters . . .

... Robbins & Myers motors power them all!

Each R&M motor, 1/200 through 200 HP, is electrically and mechanically designed with life-prolonging features which assure dependable operation, simplified installation and low maintenance. From rugged machine tools to complex business machines, there's an R&M motor for every job... Fractional and Integral H.P. Motors and Motor Parts in all popular mountings, electrical types and enclosures. Most are ready for off-theshelf delivery. Others can be quickly produced. Should you require custom motors, R&M's experienced application engineers, aided by modern electronic computers, can furnish the one design best suited to your needs.

Write today for information, or send your powering problem to R&M. No obligation, of course!

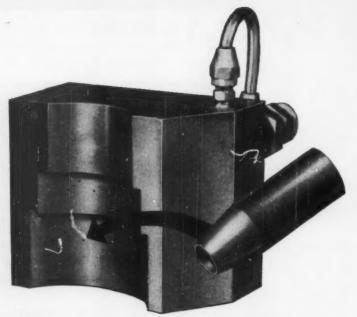


ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors * Electric Hoists and Overhead Traveling Cranes * Mayno_® Industrial Pumps

Propellair_® Industrial Fans * R & M-Hunter Fans and Electric Heat * Trade-Wind Range Hoods and Ventilators

Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.



Kentanium* outlasts copper for flame hardening nozzles

... better than 2 to 1

An automotive parts manufacturer flame hardens crankshafts and other parts with a one to four mixture of propane and oxygen. Under pressure, the impurities present in these gases tend to erode the 36 tiny nozzles contained in each half of the flame head. Accurate control of the process depends largely upon the ability of each nozzle orifice to resist erosion and maintain original size.

With copper or steel nozzles, flame head ports had to be cleaned every 40 to 45 hours, and the nozzles scrapped after eight months. On this same application, Kentanium nozzles need to be cleaned only once every two months. And, after sixteen months, the Kentanium nozzles are operating just as accurately as the first day they were put in service.

Nozzles or valve parts, cutting edges or pressure vessels...Kennametal* compositions can take just about any form to solve problems of erosion, abrasion, corrosion, impact, high pressure and extreme temperatures.

SOME OUTSTANDING PROPERTIES OF MENNAMETAL COMPOSITIONS

- YME up to 94 million psi. (Compares with steel's 30 million.)
- Density range from 5.7 to over 15.0 gms/cc (Steel—7.8).
- Compositions available to resist corrosion-wear conditions encountered with nitric, sulfuric and hydrochloric acids, and sodium hydroxide.
- Extremely hard. Up to 94 Rockwell A. (Outwears steel up to 100 to 1.)
- Kentanium retains sufficient strength for continuous operation at temperatures to 2200° F. and at higher temperatures under specific conditions.

If you'd like more information, contact a Kennametal Representative or write us direct for the booklets, "Properties of Kennametal," and "Proven Uses." Kennametal Inc., Department MD, Latrobe, Pennsylvania.

*Kennametal is the registered trademark of a series of hard carbide alloys of tungsten, tungstentitanium and tantalum. Kentanium is the registered trademark of a series for applications that require a lighter weight material, or maximum resistance to temperature extremes.

33579



by piping flow-control valves in series with the two ports used for the hydraulic section. Allenair Corp., 255 E. Second St., Mineola, N V

Circle 695 on Page 19

Magnetic Clutches, Brakes

have 80 oz-in. output torque

For applications in computer, control, and servo-positioning systems where size-to-weight ratios are critical, miniature magnetic clutches and brakes are now available. Series 11 units feature output torque of 80 oz-in. with a low power consumption of 3 w at 24 v dc. Slip rings have been eliminated, and



backlash and endplay are zero. Clutching and braking action is accomplished without angular displacement or axial motion. Units are fungus resistant, and also withstand extremes of temperature, vibration, shock, endurance, and environment. Standard temperature range is -55 to +120 C, and maximum recommended speed is 5000 rpm. Guidance Controls Corp., 110 Duffy Ave., Hicksville, L. I., N. Y.

Circle 696 on Page 19

Linear Actuator

in planetary and positive-type drives

Roton bearing screw linear actuator offers a choice of operating characteristics and linear advancements in the same screw lead. Two types of drive assemblies, planetary and positive-type, are available. Planetary drive-type bearing screw provides planetary action of the caged bearings around the screw, resulting in a mechanical reduction of linear advancement relative to the screw lead. It also features freewheeling motion at end of travel which affords complete protection to the bearing-screw

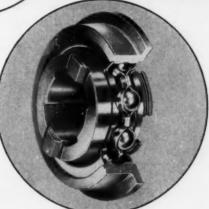


NICE "specials" provide the Product
Designer with exceptional opportunities for
cost reduction and product improvement. The
properly designed "special" not only performs its basic
bearing function, but may incorporate features that
simplify mounting or installation, or combine several
components into a single interchangeable "package"
unit.

Almost six decades of bearing experience have given NICE an unusual background of experience in the field of "specials". Hence, NICE engineers are well qualified to design bearings that will fulfill particular application requirements . . . economically and efficiently.

Can NICE help you?

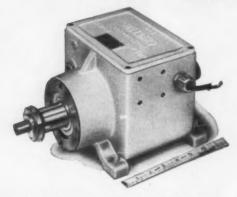




No. 7233-2 Pully bearing in clutch assembly of automatic washer. Approximately full size.

Visit Nice Booth No. 1060, Design Engineering Show, Detroit, May 22-25th

HILLIARD'S New". D. U."



A complete, packaged unit that gives you precise control of intermittent motion from a constant rotary power source!

Built-in features:

- Contains all the parts in one package.
- Can be installed as easily as a motor and needs only electrical connection.
- Self-lubricating for long life of 40,000,000 or more cycles.
- Operating speed from 40 to 400 R.P.M.
- · Torque capacity 36 ft. lbs.
- No cumulative error in cycling.
- Instant engagement.
- Mount with direct coupling connection or use with belt, chain or gear drive.

Can be installed on existing equipment, designed into new machinery and re-used after production line changes.

A single package unit that gives you precise control of intermittent motions . . . oscillate or repeat . . . clip and bend . . . shear or slash . . . raise or lower . . . index and position . . . from a constantly rotating source of power.

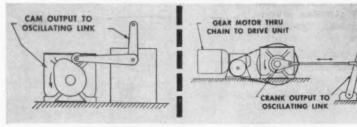
HILLIARD "I.D.U." eliminates the need of buying separate parts and assembling a "custom" machine with assorted mechanisms to control it.

to control it.

"I.D.U." features highly flexible control—manual, mechanical or electrical—permitting "demand" type operations in fixed or variable cycles. A protected drive, totally enclosed in an oil bath housing, it is ideal for dusty, "steamed" or "washdown" conditions.

Write on your letterhead stating your intermittent motion problems and we will provide complete information.

Typical intermittent controls by "I.D.U"



Basic Unit Price \$289.00

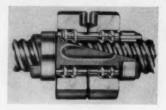
Optional accessories extra

The HILLIARD Corporation

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AMARA UPTON-HEADHER-JAMER LTD.

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assembly, motor, intervening gears, and drive pins. Positive-drive assembly produces constant positive linear advancement for those applications which require a fixed relationship between linear advancement and input revolutions, and is adaptable to multiple-screw applications requiring synchronized advancements. Roton Products Div., Anderson Co., 1075 Grant St., Gary 40, Ind.

Circle 697 on Page 19

Induction Motor

maintains rotor alignment under shock

Die-cast bearing brackets, with projections anchored in the field laminations, assure maintained rotor alignment during heavy shock in Series M shaded-pole induction motors. Bearing brackets also contain large oil-saturated felts and convenient oiling holes. Used alone or as part of a geared motor, Series M is available in four-stack thickness



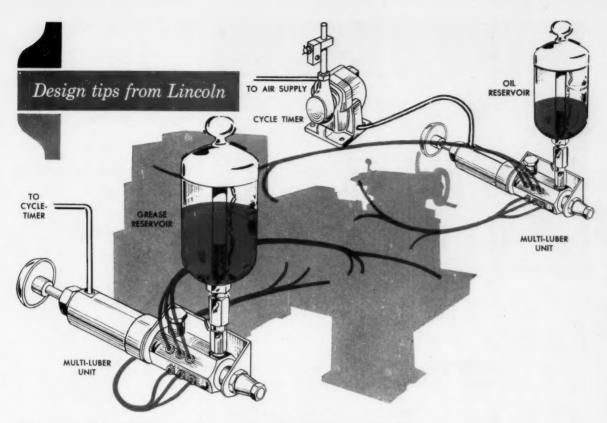
from 0.35 to 1.1 in. Maximum continuous-duty torque ratings range from 0.8 to 3 oz-in. at 120 v. Brevel Products Corp., 601 W. 26th St., New York 1, N. Y.

Circle 698 on Page 19

Vinyl-Glass Tubing

has continuous striped pattern

Turbotuf vinyl-coated glass tubing is now available with a smooth, con-



Supply Grease <u>and</u> Oil with Separate Multi-Luber Systems

You can use Lincoln's versatile Multi-Luber to provide automatic lubrication for all types of bearings on light machinery. The illustration above shows how two Multi-Luber units can be used on a machine lathe: one unit to supply special light oil for super finish spindle bearings... the other unit to supply grease to the rest of the bearings.

You can use compressed air, electricity or machine motion to cycle the Multi-Luber automatically and you can choose the lubrication timing cycle you want for each unit. The unit can also be cycled manually by pushing the plunger handle. This feature is important when light oils are used that may drain from the bearing housing. Some plants cycle the Multi-Luber manually before starting up any unit, some only after prolonged shut-down.

With standard setting, the Multi-Luber discharges 0.0025 ounces of lubricant from each of the 12 outlet ports every time it cycles. The simple Multi-Luber design and its positive displacement method of lubrication give you the most reliable system for lubricating light machines.

Investigate how Multi-Luber systems can keep the

machines you design operating at the performance level your customers expect.

Note to Manufacturers: Lincoln will help you determine the best automatic lubrication system for your machines. Contact Lincoln's Original Equipment Sales Division.

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Is This Job for You?

BACKGROUND—Recent degree in mechanical or electrical engineering. About three years of design-engineering experience.

ABILITIES—Able to evaluate technical information on design techniques, new machines, components. Provable ability to write clearly and accurately. Should work well with people, have initiative and imagination, demonstrate creative as well as practical ability.

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COMPENSATIONS—Salary comparable to that in industry. Chance to grow within the company. Unusual opportunity to broaden education, experience, and contacts. Stimulating work.

If this appeals to you not merely as a job but as the basis of a career, write at once (with all pertinent facts) to the Editor, MACHINE DESIGN, Penton Building, Cleveland 13. Ohio. tinuous striped pattern. Any color combination is furnished with either longitudinal or spiral stripes. One, two, or three stripes of the same or different colors can be supplied. William Brand-Rex Div., American Enka Corp., Concord, Mass.

Circle 699 on Page 19

Shaft-Type Oil Seal

for shaft sizes from 1/2 to 7 in.



CRS shaft-type oil seal consists of a spring-loaded sealing member securely bonded to the shell. There are no internal parts to misalign and no avenues for internal leakage. Sealing lip configuration and lip concentricity have been improved over older designs. Seal members have been strengthened by placing more material at points of major flex and wear. They are molded of Sirvene synthetic-rubber compound. Seal is available in four configurations, and is for shaft sizes from 1/2 to 7 in. Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago 22, Ill.

Circle 700 on Page 19

Hydraulic Clutches

six sizes handle torque loads from 1000 to 10,000 lb-ft

Power Shift hydraulic clutches are available as components for a wide range of transmissions and machinery. They are available in six sizes to handle torque loads from 1000 to 10,000 lb-ft, engines to 1000 hp, and speeds to 5500 rpm. Dualdrive design gives end-to-end shifting with smooth, fast engagements. Clutches shift and engage in less than 0.6 sec. When disengaged,



NEW ERIE SOLID STATE 500T BI-DIRECTIONAL CONTROL COUNTER

This is a rugged high-speed control counter with bi-directional capabilities for digital closed loop control. It offers for the first time anti-coincidence circuits for random add/subtract inputs, a digital-to-analog converter and an excess error alarm. The instrument has true modular construction in which individual circuit boards are readily inserted from the front for functional versatility and ease of maintenance. In-line NIXIE readout can be supplied when required.

The unique anti-coincidence circuit used prevents interference between add and subtract pulses arriving simultaneously. This provides absolute accuracy as opposed to conventional anti-coincidence circuits. The analog output is proportional in both magnitude and polarity to the algebraic sum of the add and subtract inputs. The readout indicates the instantaneous algebraic sum.

For example, where the 500T is used for control of motor speeds, the pulses arrive at both the add and subtract inputs at exactly the same rate when the controlled motor is running at the desired speed. Any speed change develops an analog output to a servo system which returns the motor to the proper speed. The same basic process would apply to the mixing of liquids or chemicals.

Applications for the 500T are virtually unlimited since it provides digital control of such parameters as flow, speed, position, and many others. An industrial case is available for applications in rugged environments.



Rack Mounting Model



Industrial Model

Complete technical information available on request.



ERIE PACIFIC, DIVISION OF ERIE RESISTOR CORPORATION 12932 S. Weber Way, Hawthorne, California



WAUKESHA CASTINGS

From created alloys ...



Pressures...corrosion-resistance...stability under extreme temperature variables...increased tensile strengths...only castings of created alloys can fulfill all the precise requirements of space-age technology. In less than a decade, Waukesha Foundry Company has created 5 corrosion-resistant non-galling metals.

From blueprint to finished casting, Waukesha follows your precise requirements. Facilities include "Spectrometer" control with each heat, pilot plant facilities, sand, shell and ceramic-type moldings, fully equipped finishing and polishing shop. The metallurgical staff assigned to create the alloy for your product offers over half a century of experience with created metals.

Where precision engineered castings are an absolute requirement, call on Waukesha.

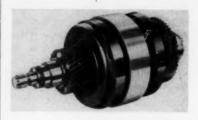
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Dept. F-23, Waukesha, Wis.

Manufacturers of corrosion-resistant castings, inclusive of non-galling alloys, Stainless Steel, Waukesha Metal, Monel, Pure Nickel, Inconel, Ni-Resist, plus special Nickel-Chromium Alloys for specific applications.



clutch cavities are under constant lube oil pressure, furnishing sufficient lubrication to all clutch parts. Rockford Clutch Div., Borg-Warner Corp., Rockford, Ill.

Circle 701 on Page 19

Phenolic Laminate

has excellent cold-punching characteristics

Insurok T-755 paper-base, phenolic laminate has stable punching properties over a wide range of low temperatures, long shelf life, high solvent resistance, and good reproducibility from shipment to shipment. Grade comes in unclad or copperclad sheets, has excellent electrical and good mechanical properties. Laminate is suitable for printed circuits and electrical and electronic components. It is also used as coldpunch material for terminal boards, instruments, and appliance component parts. Laminate is available



in standard sheet size 36 x 42 in. in unclad, and 37 x 37 or 37 x 42 in. copper-clad. Richardson Co., 2724 Lake St., Melrose Park, Ill.

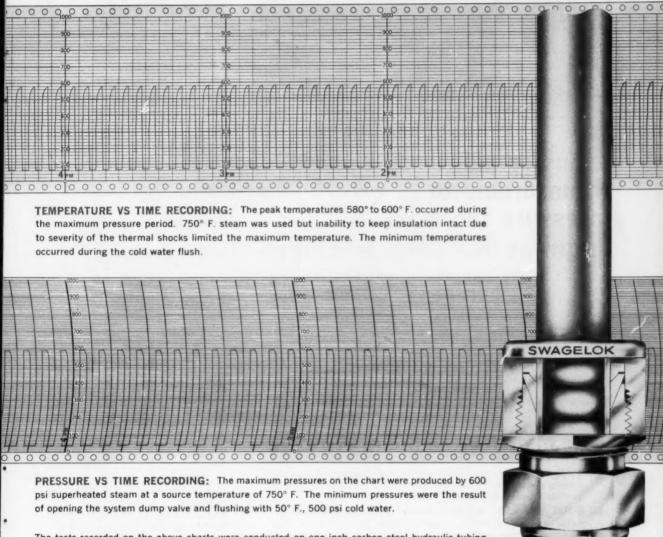
Circle 702 on Page 19

Lightweight Union

for missile and aircraft use

Astroweight union fulfills environmental and use requirements in areas where standard aircraft tube fittings have been subject to failure. Series 400,000 unit features in-

Severe Thermal Shock and Pressure Tests prove that Swagelow TUBE FITTINGS SOLVE YOUR PROBLEMS

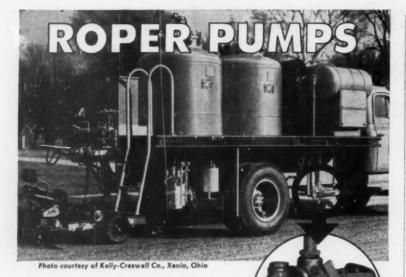


The tests recorded on the above charts were conducted on one inch carbon steel hydraulic tubing (ASTM-A-179) using carbon steel SWAGELOK Fittings. Thirteen to sixteen SWAGELOK Tube Fitting connections were in the systems and 1200 severe thermal shocks were applied on each of two different tubing configurations without leaks or failure. The conditions used in this test were considered casualty or mal-operation conditions and are not recommended practice for any system design.

These tests prove that for steam system instrumentation and steam tracing service, SWAGELOK Tube Fittings solve your problem.

Visit SWAGELOK Booth 1108 at the Design Engineering Show, Cobo Hall, Detroit, May 22-25, 1961





transfer paint from drums to pressure tanks on highway marking n

· CAPACITY: 40-300 GPM

• PRESSURE: 100 PSI

Series 3600

Roper Series 3600 pumps have been a dependable part of Kelly-Creswell highway zone marking machines for many years. The Series 3600 HBZRV-2A model transfers paint mixture from drums to pressure tanks, delivering trouble-free, low-maintenance service, even when handling light-reflective paint containing highly abrasive granules. Roper tank truck pumps are compact, complete units, built with drive shafts on upper or lower gears, depending on type of mountings to be used. Built-in steam chests are available. Series 3600 pumps are specified by many manufacturers of original equipment for the petroleum, process, packaging, and chemical industries for dependable service in handling a wide variety of liquids—thick or thin—under all kinds of industrial conditions.

GEARED TO THE ROUGHEST USE

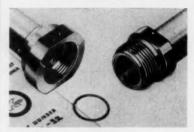
- TWO equal sized, heat-hardened alloy helical gears are the only moving parts. Perfectly balanced construction, accurate machining, provide vibration-free service.
- FOUR heavy-duty, high-lead bronze or chrome-iron bearings, hardened for long service, support pumping gears.
- PRECISION-GROUND steel shafts are induction hardened at bearing and packing surfaces. Special shaft lengths are available to fit your equipment requirements.

For information about how Roper pumps can serve your equipment, contact your Roper dealer. Send for "How to Solve Pumping Problems" booklet

ROPER
HYDRAULICS, INC.

Dependable pumps since 1857

COMMERCE, GEORGIA



ternal sealing surfaces and a replaceable, reusable metal seal which suffers no debilitation due to chemical action, radiation, age, or temperature. Union, attached positively to the tube end, is 50 per cent lighter than comparative standard AN fittings. Fittings and seals are available in corrosion-resistant steel, aluminum, and other alloys. Harrison Mfg. Co., 2908 N. Naomi St., Burbank, Calif.

Circle 703 on Page 19

Flange Nut

is combined nut and washer

New flange nut combines both nut and washer in one cold-forged piece. Flanged face eliminates the need for extra washers and can be used to gap oversized holes, provide extra bearing surface, and maintain pressure in vibration absorbers. Nut can



also be supplied with Uni-Torque locking in a wide range of sizes.

MacLean-Fogg Lock Nut Co., 5535

N. Wolcott Ave., Chicago 40, Ill.

Circle 704 on Page 19

Mylar Laminate

has good chemical and moisture resistance

X6G-280 thin, glass-cloth epoxy laminate is available in continuous sheets, strips, and coils of any length in thicknesses of 0.015, 0.022, 0.032, and 0.062 in. Laminate has excellent dielectrics, high strength-to-weight ratio, and ex-



At Lamb Electric...Engineers with FHP motor "know-how" solve intricate design problems

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If you have a special motor problem . . . here's what you can expect from Lamb. Into the design goes years of experience in power components for aircraft, domestic and industrial products. Out of the design comes a personalized motor that's dependable, smooth and efficient.

Cost-wise, you're way ahead, because Lamb Motors are mass-produced at the most favorable cost.

Write today for descriptive folder. Or ask to have a District Engineer call and set up a personalized "Motor Conference".

THE LAMB ELECTRIC COMPANY · Kent. Ohio

A Division of American Machine and Metals, Inc.
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Leaside. Ontario

Lamb Electric

Circle 421 on Page 19

Divisions of American Machine and Metals, Inc., New York 7, New York TROY LAUNDRY MACHINERY RIEHLE TESTING MACHINES . DE BOTHEZAT FANS . TOLHURST CENTRIFUGALS . FILTRATION ENGINEERS . FILTRATION FABRICS NIAGARA FILTERS . UNITED STATES GAUGE . RAHM INSTRUMENTS . LAMB ELECTRIC CO. . HUNTER SPRING CO. . GLASER-STEERS CORP.

Maxitorq Disc-bac

CLUTCH OR BRAKE ASSEMBLY

Takes performance guesswork out of power transmission design

With these performance-proved units, you can save time and money in designing and building clutches and brakes exactly tailored to the requirements of your application. At the same time, you can be sure that they will equal the performance and smooth operation of proved MAXITORQ clutches and brakes. DISC-PACS are simply the "heart" of a clutch or brake...the discs, separator springs, and locking plate... supplied as a complete self-contained unit for the convenience of design engineers and equipment builders.

Produced in a full range of sizes and capacities from ¼ h.p. to 15 h.p. Bulletins available on other MAXITORQ products: Floating Disc clutches and brakes, Electric clutches, Overload Release clutches, low-cost Single Disc clutches, and clutch or brake friction discs. Write Dept. MD.



THE CARLYLE JOHNSON MACHINE CO.

MANCHESTER, CONNECTICUT

3CJ60

NEW PARTS AND MATERIALS

cellent chemical and moisture resistance. Pore-free, high dielectric surfaces are provided by Mylar which is bonded to both faces. Bond strength exceeds 750 psi. Swedlow Inc., Box 2334, Youngstown 9, Ohio.

Circle 705 on Page 19

Wood Insert

provides high strength in blind and through holes

High-strength, low-cost wood insert, Groov-Pin WH-series, is die cast of Zamak. It is suitable for use in blind holes as well as through holes.



and is available in $^{1}\!/_{4}$ -20, 5/16-18, and $^{3}\!/_{8}$ -16 sizes. Groove-Pin Corp., 1125 Hendricks Causeway, Ridgefield. N. I.

Circle 706 on Page 19

Silicone-Epoxy Compounds

for potting, caulking, and encapsulation

Eccosil epoxy-silicone rubber compounds are available for potting, impregnating, caulking, and molding in a variety of applications. Eccosil 4850 is a general-purpose RTV silicone-rubber compound, with a temperature capability to 600 F, used for potting, caulking, and mold making. Eccosil 4640 is a low-weight RTV silicone rubber with 600 F temperature capability. Weight is under 40 lb per cu ft. This material is for airborne applications. Eccosil 4712, a general-purpose epoxy-silicone, has 450 F temperature capability. Available for potting applications, it retains flexibility after heat aging. Eccosil 4520, a low-viscosity, epoxy-silicone impregnant and potting compound, has 450 F temperature capability. Applications include impregnating

and dip-coating transformers and coils. Emerson & Cuming Inc., Canton, Mass.

Circle 707 on Page 19

Teflon Sheet

is available in large sizes

Sheet forms of Teflon TFE-fluorocarbon resin up to 8 in, thick and 25 in, square are now available. Sheets are designed to provide fabricating savings and new design possibilities in the electrical, chemical, and mechanical industries. Polymer Corp., 2120 Fairmont Ave., Reading, Pa.

Circle 708 on Page 19

Tubing Valve

for temperatures to 1000 F at pressures to 30,000 psi

Hi-Temp stainless-steel tubing valve incorporates an elongated stuffing box which removes the packing from the "hot zone" in the valve body. Valve is designed for gas or liquid service at temperatures to 1000 F and at pressures to 30,000 psi. Two-piece stem does not rotate against the seat, eliminating the possibility



of galling or scoring either seat or stem. Autoclave Engineers Inc., 2945 W. 22nd St., Erie, Pa.

Circle 709 on Page 19

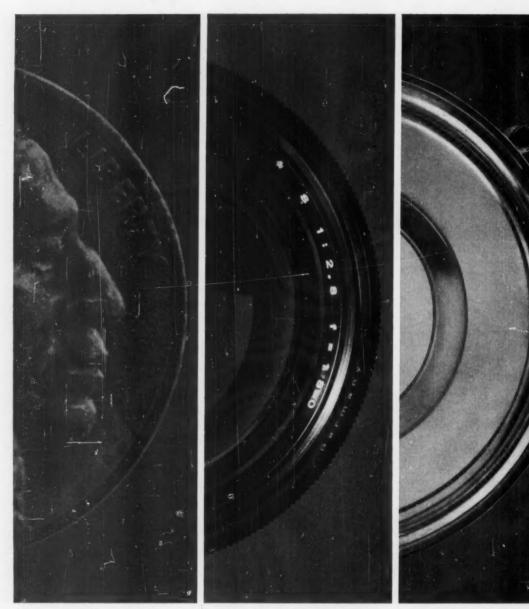
Air Power Cylinders

can be side, cap-end, or head-end mounted

Series C 200-psi air cylinder is available in 1½, 1¾, 2½, 35%, and 4½-in. bore sizes with standard strokes to 20 in., single and double rod-end models, in three basic

(Please turn to Page 342)



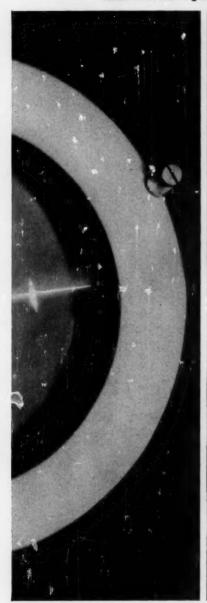


Keeping tabs on the nickels, dimes, quarters that go into hundreds of vending machines—that's what Veeder-Root electrical and mechanical counters do with unfailing accuracy.

Special instrument counters play an important role on aerial cameras for many jobs such as locating plant sites, mineral prospecting and for general reconnaissance.

In making tin cans, and in packaging them, Veeder-Root electronic counters with photo electric input record production at speeds up to 300,000 units per minute.

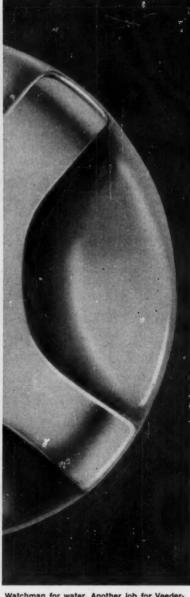
Regulate, Actuate, Correlate with Veeder-Root Counters! Here's a fast, low-cost way for you to record facts...co-ordinate operations...automate your plant machinery. Whether you include these versatile counters in your new



Radar and missile-tracking systems rely on the positive precision of Veeder-Root instrument counters for instant read-out of range and azimuth or coordinate position.



Veeder-Root Indicating and remote digital read-out counters help maintain inventory control of packaged and fluid goods, recording usage, balance on hand, re-ordering points.



Watchman for water. Another job for Veeder-Root counters. Installed on modern meters, these mechanical counters gauge flow...prevent waste of industry's precious raw material.

designs or add them to your present production line you increase equipment value and performance. Send for details on the latest developments. Write Veeder-Root Inc., Hartford 2, Connecticut. count on Veeder-Root

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POSITIVE CONTROL FOR PROBLEM FLUIDS!

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BANTAM features include excellent flow characteristics, low hysteresis, and fast response. Offered in a wide selection of pneumatic operators and control positioners, standard models are rated at pressures up to 1000 psi at 450°F. Compactness, quality construction, and ruggedness also contribute to their virtually unlimited application versatility.

REQUEST Catalog B-1 for complete data on these versatile valves... for positive control of your problem fluids! G. W. Dahl Co., Inc., 83 Tupelo Street, Bristol, Rhode Island.

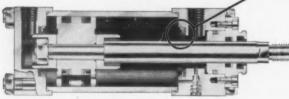
G. W. DAHL CO., INC.

SPECIALISTS IN COMPACT VALVES AND CONTROLS

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WILBOW precision seals improve power cylinder action





Check seal cushions by WILBOW provide effective cushioning of HANNA-POWR®* AIR Cylinders.

.07.7

SEND FOR COMPLETE WILBOW CATALOG Each cushion valve in The Hanna POWRMATION® Cylinder shown above has been precision engineered and manufactured to stop heavy and fast moving loads without severe impact or bounce. Seals conform to high standards including excellent uniformity and long life—thanks to the special properties of the synthetic materials used and the manufacturing experience of WILBOW in producing custom rubber parts.

WILBOW specializes in the manufacture of precision mechanical rubber parts to meet the most rigid performance requirements. A full range of the newer synthetics, natural or silicone polymers plus the broadest production versatility...including molding, lathe cutting, extruding or punching... is at your service. Why not check your needs with WILBOW?

*HANNA-POWR and POWRMATION are registered trademarks of Hanna Engineering Works, Chicago, Ill.

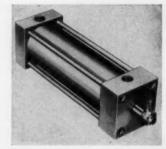
The WILLIAMS-BOWMAN RUBBER CO.

1951 South 54th Avenue . Cicero 50, Illinois . (Chicago Suburb)

Mfrs. of molded, punched, extruded and cut rubber goods. Specialists in producing rubber covered rolls, silicone rubber parts and bonding rubber to metal

NEW PARTS AND MATERIALS

(Continued from Page 339)



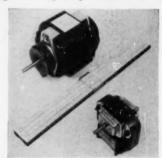
mounting positions — side, cap-end, or head-end. Friction is minimized by an oil-impregnated, bronze-rod bushing. Hannifin Co., Dept. 116, 501 S. Wolf Rd., Des Plaines, Ill.

Circle 710 on Page 19

Subfractional-Hp Motors

have high starting torque

Model L subfractional-horsepower motor is a 117-v, shaded-pole induction unit designed specifically for typewriters, business machines, and similar equipment demanding high torque, compact design, and low cost. It is available with or without clutch. Model H features high starting torque combined with



compact size, making it suited to gear trains, air circulation, and remote controls. Alliance Mfg. Co., Dept. MJ, Alliance, Ohio.

Circle 711 on Page 19

Printed-Circuit Connectors

resist vibration over 40g

Fuz-lock printed-circuit connectors have female contacts similar to miniaturized fuse clips. Units sustain prolonged vibration of over 40g from 5 to 2000 cps without circuit discontinuity. Positive pressure and moisture seals are provided. Design temperature is -60 to +450 F.



Modern hydraulic forging press exerts 35.000 tons pressure.

In an airliner, every pound of weight saved is worth hundreds of dollars ... in revenue-making payload. And in military aircraft, pounds saved mean added miles-per-hour... or added load carried.

In commercial products...trucks, cars, materials-handling equipment... the pounds of dead weight you eliminate by using forgings make money year-after-year for the operator. The forging process lets you put the metal exactly where you need it to carry the load, withstand shock or vibration, endure torsion. And with not a surplus ounce of non-working weight going along just for the ride.

Forged parts are the designer's friend...strong where strength is needed, lowest in weight, twice-worked by original rolling of the best metals plus the hammer blows or high pressures of the forging process.

Write for literature to help you specify, design, and procure forged parts.

SEE THE STORY OF FORGING RELIABILITY
BOOTH 204
DESIGN ENGINEERING SHOW
DETROIT, MAY 22-25

When it's a vital part, design it to be FORGE



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Names of sponsoring companies on request to this magazine

SMITH cam followers and yoke rollers

engineered to precise standards



Each component of every Smith Cam Follower and Yoke Roller is carefully engineered, machined and finished to the most exacting standards and dimensions. As a result, Smith Cam Followers and Yoke Rollers perform with uniform reliability.

Standard Smith "CTA" (interchangeable) or "HCS" (High Capacity Stud) Cam Followers and "CTY" Yoke Rollers will give you outstanding performance with long, trouble-free life.



Smith/Align Bearings are new self-aligning bearings that are specifically designed for applications which are extremely critical-where dependable performance is vital and failure too costly to tolerate. Smith/Align Bearings will function smoothly, without bind, yet with as little as .0002" clearance between ring and ball.

Better distributors throughout the country stock and sell Smith Cam Followers and Yoke Rollers.

Write for the handy, quick reference data sheets on Smith Cam Followers and Yoke Rollers and for full information on Smith/Align Bearings.

Smith Bearing Division / Accurate Bushing Company 441 North Avenue, Garwood, New Jersey

Manufacturers of: Needle Bearings, Cam Followers, Yoke Rollers, Jet Engine After Burner Rollers and Bearing Assemblies, Airframe Standard and Special Bearings, High Temperature and Severe Wear Precision Parts.

NEW PARTS AND MATERIALS



Male contacts with 0.156-in. spacing are staked to printed-circuit boards or tape cable without soldering. Single and double-sided connectors provide circuit combinations for boards, tape, and wiring for 5 to 86 contacts. Matrix Science Corp., 3311 Winona Ave., Burbank, Calif. Circle 712 on Page 19

Flow Meters

have interchangeable tubes

New flow meters are available for purge and low-flow applications. Basic unit, Model 125, features interchangeable tubes, a rigid body, and intergral characterized needle valve with stainless-steel or glass floats. One-piece body construction features Plexiglas shield which provides side-lighting of the tube for easy readability. It is available in either chromed brass or type 316 stainless. Interchangeable tubes provide a range of 0.2 to 90 scf per



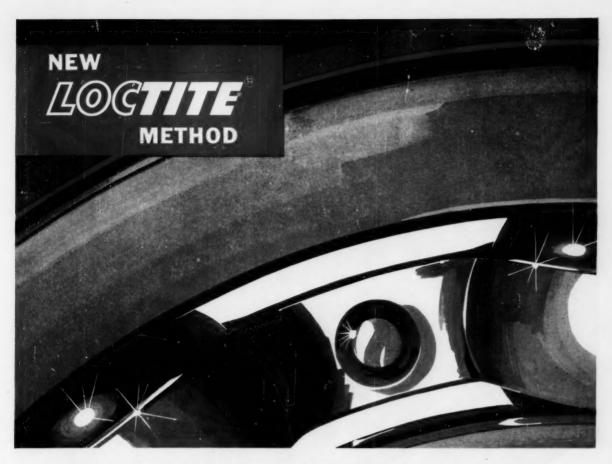
hour of air and 0.05 to 20 gph of water. Devco Inc., Box 374, Hatboro, Pa.

Circle 713 on Page 19

Indicator-Light Capsules

have three-color legend area

Tri-Color indicator light capsules have legend areas illuminated in any one of three colors. White lamps and a color filter provide the three colors in a single indicator



IMPROVES RELIABILITY OF PRESS FITS ... CUTS COSTS

...without A Penny Invested in Equipment!

Simply apply a few drops of LOCTITE Sealant to press fit assemblies. Look at these production assembly advantages:

- Greatly increases reliability of interference fits and other methods of metal-to-metal assembly.
- Requires no expensive equipment—the plastic bottle is the applicator. Can be used for automatic or mass application with simple "around-the-shop" parts.
- Increases allowable tolerances—reduces machining costs.
- Reduces materials costs—minimizes design requirements.
- Facilitates assembly of delicate parts—reduces danger of deformation.
- Facilitates proper concentric fit of mated parts in lineto-line fits—this liquid-turned-to-solid mates parts better than any metal-to-metal contact possible.

. . . and parts can be disassembled with standard tools and techniques.

WHAT IS LOCTITE? LOCTITE Sealant is a penetrating liquid resin with low viscosity that hardens when confined between closely fitted metal surfaces. It "wicks in" between the most closely mated of matched precision surfaces and hardens into a strong, heat-, oil-, grease-, solvent- and vibration-resistant bond. LOCTITE completely fills the

space between the surfaces . . . adds its sheer strength to that of the press fit. There are no solvents to evaporate —no catalyst to mix.

On the production assembly line and in other areas, too, the LOCTITE Method replaces and improves many different mechanical means of locking—retaining—sealing. LOCTITE Sealant has already brought these benefits and savings to such leading companies as:

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Consolidated Diesel Electric Corp.
The Maytag Company
Westinghouse Electric Corp.
General Dynamics Corporation,
Electric Boat Division
Reeves Instrument Corporation

Norge Division, Borg-Warner Remington Rand Univac Philco Corp.—Government & Industrial Div. General Electric Company Raytheon Mfg. Co. McDonnell Aircraft Corporation

Veeder Root, Inc.

Details on your particular application bring immediate response from our Application Engineering Dept. Or, better yet—make your own convincing test. Mail check for Test Kit No. 10-10 (\$16.50 complete).

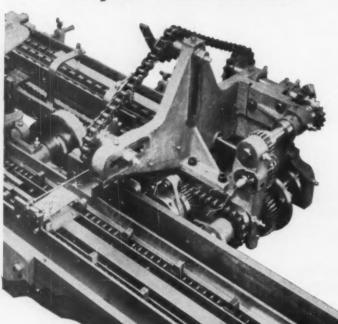


American Sealants Company • 111 North Mountain Road
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DO YOU HAVE THE BEST CHAIN SELECTION

For Efficient Operation of your installation?



Without correct size chaining, you are risking the chance of breakdown that can severely set back production and result in loss of profit and payment of overhead on unproductive machinery.

Consult Acme's Engineering Department for assistance in selecting the proper chain for your installation. By taking into consideration such factors as horsepower to be transmitted, size and speed of shaft, space limitations, etc. this will determine the standard size of chain required to do the job best. This size or any other can be obtained off-the-shelf from your local Industrial Distributor.

Your Industrial Distributor can supply you promptly with Acme Roller Chains in 12 standard sizes from $\frac{1}{4}$ " pitch to $\frac{21}{2}$ " pitch. He has the full cooperation of our Engineering Department. Contact him.



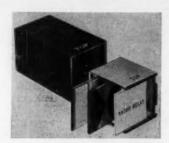


Write Dept. 6-L for new ill. 100 page catalog with engineering section.



RELIABLE CHAIN DRIVES FOR ALL INDUSTRIES

ROLLER CHAINS, SPROCKETS, CONVEYOR CHAINS, FLEXIBLE COUPLINGS, ATTACHMENTS. (Special and Standard)



unit. Capsules use miniaturized circuitry and components for instantaneous display of visual information in color and in small packages. Units can be mounted in compact modular arrangements flush with the panel, side-by-side, or stacked vertically. Single light assembly can be removed from a stack without disturbing the others. Color filters, nomenclature strips, and lamps are readily changed by pressing on the lens to eject. Radar Relay Inc., 2322 Michigan Ave., Santa Monica, Calif.

Circle 714 on Page 19

Urethane Foam

has self-adhesive backing

Pressure-sensitive urethane foam, after removal of its paper backing, adheres firmly to any clean, dry surface. Foam is unaffected by repeated flexing and prolonged compression, has excellent vibrationdamping and sound-absorbing qualities, and resists water, oils, chemicals, rot, fungus, mildew, and termites. It is available for a wide variety of cushioning, insulating, and sealing applications. Foam is produced in sizes, shapes, and colors to meet customer specifications. Air-O-Plastic Corp., Union City, N. I.

Circle 715 on Page 19

Electrical Outlet, Plug

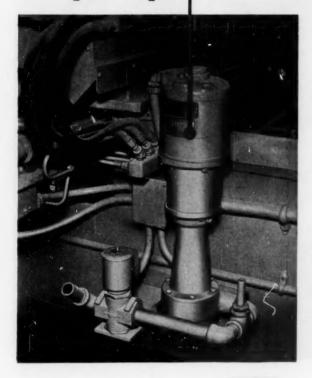
for hazardous industrial atmospheres

Hubbellock explosionproof electrical receptacle and plug prevent arcing





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In their 100 years of pump progress, Ingersoll-Rand has established a reputation for solving liquid movement problems for machine builders. Famous I-R engineering is unmatched anywhere . . . whatever your design requirements for mounting, flow or pressure, there are thousands of models and types to choose from . . . or we'll make one to suit your most exacting need.

Why not check with the world's foremost centrifugal pump builder regarding your pumping problems. You can get complete details from the pump specialist at your nearby I-R branch office—or direct from our New York headquarters.

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when appliances are connected or disconnected at wall outlets. To prevent explosive gases or fluids from accumulating inside the plug. plug is designed so that a self-hardening, epoxy insulating resin is poured into its shell at the time the three-wire appliance cord is fastened to its terminals. Insulating resin fills all air spaces where flammable gases or moisture might collect inside the plug, and hardens to form a watertight, vaportight mass. Connections cannot loosen to cause sparking, and plug and cord can be washed safely when plug is removed from wall outlet. Explosionproof wall outlet receptacle allows no current to flow through it unless plug has been completely inserted and rotated 22-25 deg clockwise. Harvey Hubbell Inc., State & Thomas Streets, Bridgeport, Conn.

Circle 716 on Page 19

Sight-Flow Indicator

for checking fluid in pipeline



Flow-Eye sight-flow indicator has double sight glasses for clear observation of fluid in a pipeline, even under poor lighting conditions. It uses machined recesses and retaining rings for even seating of the sight-glass gaskets to prevent leakage. Schutte & Koerting Co., Dept. M-V, Cornwells Heights, Bucks County, Pa.

Circle 717 on Page 19

General-Purpose Relay

is small, four-pole, double-throw type

KHP relay, slightly larger than 1 cu in., is a 4PDT unit rated for loads from dry circuit to 3 amp at 30 v dc or 115 v ac resistive. Coiloperating voltages range from 6 to 110 v dc. The general-purpose



Should auld acquaintance be forgot?

Except for depressions, floods and famines, the sales of one of our real old-timers have been booming every year since its introduction in 1944. The whole thing got started when we were requested to build a precision DC relay for floating mines that would surely work after it and the mine had been dropped out of an airplane. We tried, and the relay worked - until the mine went off. After the smoke cleared, and small, long-lived rectifiers and diodes came along, an AC version was hatched. Seventeen years later, it's no surprise (to us, at least) that 34 standard variations have successfully found their way into customers' circuits.

This acme of perfection, reliability and joy to the Management's heart is the Series 5, which is used in either AC or DC circuits to provide: release and operate points very close together; break delay; constant operate voltage despite wide temperature variation; dual coils for differential operation; or meter protection from DC voltage

or current overloads. The "5" can operate on as little as 1 mw., contacts will switch up to 3 amps (depending on sensitivity), and available enclosures range from none to hermetically sealed.

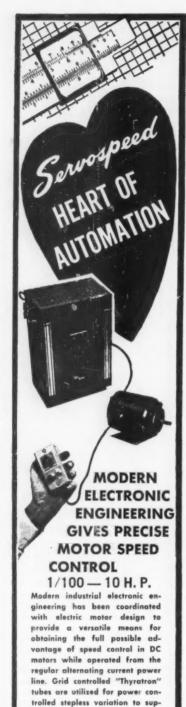
The Series 5 relay is now widely used in burglar alarms, coin-operated arcade games, temperature monitoring controls with Sigma Magnetic Amplifier Relays, boiler water salinity controls, battery chargers and R/C models, as well as in G.I. equipment. The reasons are probably (1) its combination of high sensitivity and stability in hard-knock applications, (2) the "special" characteristics you can get, usually at non-special prices, and (3) the fact that the relay works the way the specs say it does.

This has been No. 113 in an endless series of messages designed to focus public attention on Sigma's sincere desire to sell relays.

At the DESIGN ENGINEERING SHOW Sigma products on display at Booth 211 May 22-25 Cobo Hall, Detroit

SIGMA

SIGMA INSTRUMENTS, INC. 89 Pearl Street, So. Braintree 85, Mass.





unit operates on as little as 0.5 w minimum power, 0.9 w nominal, and 2.0 w maximum at 25 C. Relay incorporates a translucent nylon dust cover. Potter & Brumfield, Div., American Machine & Foundry Co., Princeton, Ind.

Circle 718 on Page 19

Pushbutton Enclosures

have sloping front configuration

Line of pushbutton enclosures is for use wherever slanted control surfaces are needed, and can be mounted on the tops or sides of machinery with the working surface in any desired plane. Box is available in 13 sizes—for one to 25 pushbuttons. Holes take all makes of standard-size, heavy-duty, oiltight pushbuttons. Entire box is 14-gage sheet steel with welded seams. En-

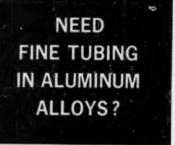


closures are completely oil and dusttight and cannot crack. Hoffman Engineering Corp., Anoka, Minn. Circle 719 on Page 19

Copper-Clad Laminates

are fire-retardant, cold-punched types

Principal applications of two new fire-retardant, cold-punch, copperclad laminates, paper-base phenolics of XXXPC grade, are expected to be in radio and television printed circuits. Grade 65MO5 is recommended for small circuits or miniaturization. It has high bond strength and high solder resistance. The 65MO6 laminate is suitable in automatic fabrication processes





● Production mills provide rough drawn aluminum alloy tubing in the standard, large sizes. But the redrawing of fine, seamless tubing with any needed O.D. between 0.010" and 0.375" and wall thicknesses from 0.035" ±0.0005" to 0.001" ±0.00025" is UNIFORM's specialty. UNIFORM TUBES provides the precision aluminum alloy tubing such as that which goes into the fabrication of lightweight, highly accurate instrument pointers and other critical applications.

Through skills developed over the years and by continuing devotion to precision craftsmanship, UNIFORM meets close tolerances in every dimension even cutting tubing in lengths to ±0.003". Tubing ends are always free of burrs and concentricity is preserved.

Fine tubing drawn to your specification is available in high purity aluminum and aluminum alloys 1080-C, 1100, 2024, 3003, 5052, 6061, 6951, 7075 and the new high-strength alloy UT-58.

Even though tubing is drawn to your exacting requirements, if you need delivery "yesterday," UNIFORM will produce fastest delivery possible. Write for information on this tubing or on tubular parts fabricated "at the mill" from these alloys as well as alloys of copper, nickel, steel and the precious metals. Sizes up to 3%-inch O.D. on application.



Godwin Ave., Paterson, N. J

ply motor armature power.

Patented feedback, or "Servo"

circuits provide constant torque

capability over wide speed ranges

of as high as 60 to 1 in some models and a minimum of 20

to 1 in others.



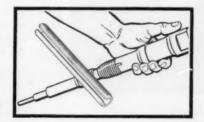
Rollpin aids standardization and reduces inventory

Rollpin readily replaces taper pins, grooved pins, straight pins and set screws; it can be used as a locating dowel, hinge pin, cotter pin, stop pin or, in some applications, even as a rivet. Thus, when you standardize on a Rollpin you can drastically reduce the variety of fasteners in your inventory-save money in purchasing, storage space and stock handling.



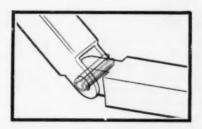
Rollpin simplifies production processing . . . saves man-hours

When you use Rollpin you can eliminate costly precision drilling, or tapping operations. And there's no need for any secondary locking operation-such as lock wiring or peening. That's because Rollpin is a slotted tubular steel spring whose chamfered ends drive easily into standard production-drilled holes, compressing as driven. The spring tension against the hole walls retains Rollpins securely against severe vibration. Independent studies have shown that installed costs of Rollpin are as much as 91% less than those for a dowel pin or 95% less than the installed cost of a taper pin.



Rollpin simplifies product maintenance

Only a drift pin or standard punch is required to remove a Rollpin. The slotted tubular shape and the spring action principle do not damage hole walls or enlarge the original hole diameter. Consequently the same pin is easily re-inserted and can be used again and again. Mail our coupon today for the complete Rollpin story.





Elastic Stop Nut Corporation of America

Dept.	R58-5	54	Elastic	Stop	Nut
Corpor	ation	of	Ameri	ica	
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Let Warner Automotive's staff develop a special gear box for your needs, as was done for the CASE 200 Hay Baler . . . a rugged, dependable, yet lighterweight gear box with housing of malleable iron, hypoid gears carburized for long life, integral ring gear carrier and splined crankshaft, tapered root spline on input shaft, anti-friction bearings throughout. Consult Warner on any mechanical power transmission problemwithout obligation.



AUTOMOTIVE DIVISION

BORG-WARNER CORPORATION AUBURN, INDIANA

For Hydraulic Power Transmission, See Wooster Division

Hydraulic Gages are direct-action completely enclosed units

Compact hydraulic gages are calibrated in four pressure ranges, and operate on the positive direct-action principle. Spring-loaded, pressure-



that require close registration of holes and circuits. Laminate is warp-free, has high impact strength, high adhesion, high insulation resistance, and low moisture absorption. Micarta Div., Westinghouse Electric Corp., Hampton, S. C.

Circle 720 on Page 19

Centrifugal Pumps

with capacities to 400 gpm and heads to 150 ft

Packaged, close-coupled, end-suction centrifugal pumps are available in a range of sizes from 3/4 x 1 to 3 x 3 in. Capacities range to 400 gpm and heads to 150 ft. Complete disassembly without disturbing suction or discharge piping simplifies inspection and maintenance. Vertical centerline discharge makes the pumps self-venting, eliminating the possibility of vapor lock and providing smooth-running operation

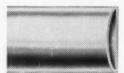


with low noise level. Stainless-steel, 3/4 in. diam through seal assembly eliminates deflection and assures long seal life. Aurora Pump Div., New York Air Brake Co., Aurora, III.

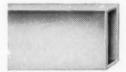
Circle 721 on Page 19



.010" to 1.125" O.D. . . . wall thickness down to 0.0015" . . . held to extremely close tolurances.



Round, rectangular, oval or squ —formed to any specifications.



Copper, brass, aluminum, nickel and nickel-alloys, Ni-Span C, phos-phor-bronze and nickel silver.



ECHNICAL DATA

..., to help your product. Write for Tubing Know-How Booklet to Precision Tube Company, North





... saves 35 machining operations

This target revolver barrel is now being made by the new Hitchiner Ceramic Shell technique of investment casting. Thirty-five machining operations are eliminated! The only external finishing required is partial polishing.

Investment casting may provide many benefits for you...choice of alloy...flexibility of design... improved parts performance... reduction of costs. Maybe one of your parts can be made better for less. Write for

complete technical and facilities information.

HITCHINER

Millord 3, New Hampshire

sensing mechanism is protected from shock damage and pressure over-loads by a built-in dampening device. Size of the gages is 21/4 x 23/8 x 1½ in. They are completely enclosed in hammer-tone finished aluminum cases with clear-plastic faceplates. Dial faces are white, corrosion-resistant plastic with black calibration numerals and graduation lines. Front-of-gage adjusting screw permits resetting to zero. Gages are available in four psig ranges, All replaceable internal parts are com-



pletely interchangeable. A. Schrader's Son Div., Scovill Mfg. Co. Inc., 470 Vanderbilt Ave., Brooklyn,

Circle 722 on Page 19

Manual Starter

for use with fractional-horsepower motors

Electric Class 10 starter provides manual, across-the-line, start-stop, or off-on control of fractional and 1 hp, single-phase electric motors. Single and two-pole devices include a built-in, tripfree thermal relay to protect the motor from sustained overload. Two-pole starters are required to break both lines for dc applications, and are recommended for severe ac applications. Incandescent or neon pilot lights to indicate operational status, and toggle guards which accept a padlock are optional equipment. Tripfree, melt-





Use the unique precision of Wooster's 2D Directional Control Valve . . . parallel circuit, open center, stack type with simple 3-bolt mounting .. to control the lifting, tilting, positioning of agricultural implements, materials handling, mobile equipment and industrial applications. Operating pressures to 2000 PSI with extremely low losses. Built-in switch valve to change from 4- to 3-way operation in the field. Produced on building block principle, materially lowering cost without sacrifice of quality.



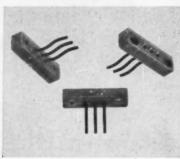
353

BORG-WARNER CORPORATION WOOSTER, OHIO

For Mechanical Power Transmission, See Warner Automotive Division

HAVELEX

Haveg's Precision Molded Rigid Inorganic INSULATING MATERIAL



Havelex's unusual combination of properties cou pled with Haveg's broad experience in custom molding intricate shapes offers unlimited design possibilities. Pictured above is a recent example of how Haveg solved an important problem with

major transistor manufacturer wanted thinwalled metal tubes precision molded into an inorganic material for high temperature testing of his product. The tubes were contoured to facili-tate lead insertion and removal—yet insure elec-trical contact during the testing period.

Haveg engineers will be happy to work with you on your particular project—to help you "Keep ahead with Haveg." Havelex offers all of these unique features

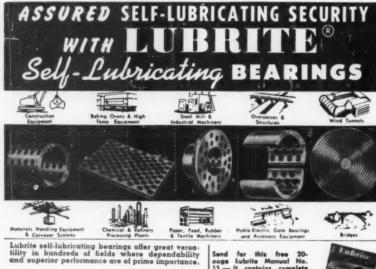
- Dimensional
- Stability 1000°F. Continuous Temperature Resistance
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- · Low Loss, Low
- Power Factor Arc Resistance
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- Integrally Moulded **Metal Inserts**
- Hermetically

Sealed Inserts



HAVEG INDUSTRIES, INC.

Circle 442 on Page 19



Lubrite Bearings, with clean, permanent, maintenance-free self-lubrication are designed to withstand severe loadings, temperature extremes, submersion, corrosion and other adverse conditions.

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INC. 188 AMORY STREET, BOSTON 30, MASSACHUSETTS

ing-alloy-type, thermal-relay contacts cannot be closed until overload has been eliminated and eutectic alloy solidified. Furnas Electric Co., 1045 McKee St., Batavia, Ill. Circle 723 on Page 19

Automatic Clutch

for gasoline and diesel 6 to 10 hp engines

Centri-Dyne automatic clutch line offers a wide range of models including standard sizes of single and double-groove sheaves, chain sprockets, timing-belt pulleys, and directcoupling clutches. It is for use with gasoline and diesel engines of 6 to 10 hp. Light, strong, heavy-gage-



steel construction provides a built-in forced draft ventilation for cooler operation. Salsbury Corp., 1161 E. Florence Ave., Los Angeles 1, Calif.

Circle 724 on Page 19

Adhesive Coating

conducts static charges away from metal, glass, plastic

Rez-N-Glue 159 is a synthetic-rubber-base adhesive that provides excellent specific adhesion to metals, glass, some plastics, and most porous materials for the conducting away of static charges. Resistance of the black adhesive coating to oil, gasoline, water, heat, and cold make it suited for use as a protective coating against rust and corrosion. Coatings can be applied by brushing, and each coat produces approximately a 2-mil thickness of static-conducting surface. Corrosion-resistant coatings result from the application of two or more brush coats with allowance of about 1 hr drying time between coats. Adhesive produces a tough, elastic



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476 Vanderbilt Avenue, Brooklyn 38, N. Y.

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They are available from your local bearing distributor in a wide range of sizes and materials, including sintered metal components, and teflon linings for self-lubrication.



The single ball construction of the Unibal Spherical Bearing permits its comparatively simple adaptation to special applications such as this double offset link.





Rod Ends as used in the linkage for the dampener insulation on the Atlas fuel manifold.



Spherical Bearing assembled
with the variable pitch stator vanes in the
jet engine, act
as the pivot
points.

For sales or engineering aid, or for catalog or latest bulletins, see your bearing engineering specialist, or write:

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

coating that becomes tougher and more heat resistant over a period of months. Schwartz Chemical Co. Inc., 50-01 Second St., Long Island City 1, N. Y.

Circle 725 on Page 19

Foot Switch

meets dual control needs



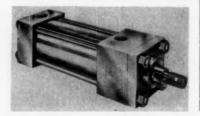
Positive control of up-down, slowfast, and other reversible operations is made easier, with less foot pressure, by heavy-duty Clipper Twin foot switch. Each of the two foot switches, mounted on a common steel baseplate, provides a momentary contact for SPDT circuits rated to 20 amp, 125-250 v ac, and 1 hp, 115-230 v ac. Only one external power cable is needed, as a tube between treadles conceals internal wiring. Skidproof base prevents sliding, while four mounting holes allow rigid attachment to floor or equipment. Over-all size of the unit is $8\frac{3}{8}$ in. wide, $4\frac{1}{2}$ in. deep, and 11/2 in. high at the treadle operating end. Linemaster Switch Corp., 432 Woodstock Terrace, Woodstock, Conn.

Circle 726 on Page 19

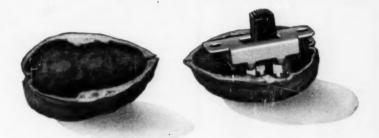
Air Cylinder

is rated 200 psi

Series K air cylinder features a colddrawn brass cylinder barrel; hard chrome-plated, high-tensile-steel piston rod with minimum yield strength of 90,000 to 100,000 psi; rolled-steel heads; and long, cartridge-type rod bearing. Fabricated



6-amp jobs for low cost slide switches as small...



as 3-amp and 1-amp Stackpole Slide Switches

With dependable switches such as this 6-ampere Type SS-36-1 you can often make cost savings up to 50% over conventional appliance switches . . . and improve the convenience and styling of your electrical products in the bargain!

New Stackpole SS-36-1 is but one of 15 standard types with U.L.I. ratings from 0.5 to 6 ampere that cover practically any needed switching arrangement from SP-ST to 4-position, multi-pole. And trigger knobs in 10 attractive colors add real decorative appeal.

Write for Bulletin RC-12D for full details on today's most complete line of versatile slide switches and accessories.

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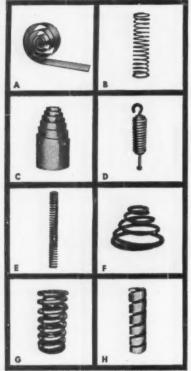
STACKPOLE CARBON CO., St. Marys, Pa.



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Circle 447 on Page 19

NEW PARTS AND MATERIALS

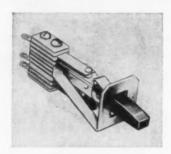
steel mounts and accessories are available for bore sizes $1\frac{1}{2}$ to 14 in. Ortman-Miller Machine Co., 19 143rd St., Hammond, Ind.

Circle 727 on Page 19

Toggle Switch

for use in electronic equipment

Series 23000 toggle switch, available for general use in all types of electronic equipment, provides long spring-action life, accomplished by the use of relatively long springs without any forms at the point of flexing. Switch also provides: Multiplicity of circuits; three-position, toggle-type switch or a two-posi-



tion switch with momentary or locking action; choice of contacts in fine silver or palladium. Silver is rated at 3 amp, 120 v ac non-inductive. Switch frame has four tapped screw holes for convenience of panel mounting. Switches can be mounted on ¾-in. centers with No. 3-48 machine screws. Switchcraft Inc., 5555 N. Elston Ave., Chicago 30, Ill.

Circle 728 on Page 19

Drum-Sprocket Brake

for scooter-type vehicles

A 5-in. combination drum-sprocket brake assembly is applicable on installations where space is limited between the axle suspension points, such as on scooter-type vehicles. Lever-actuated, internally expanding brake mechanism is mounted on the axle and remains stationary. Drum and driven sprocket, fabricated in one piece, revolves around the brake mechanism. Drum is flanged to form the sprocket. Two sizes of drum-sprockets are available—7.38 and 8.81 in. diam.

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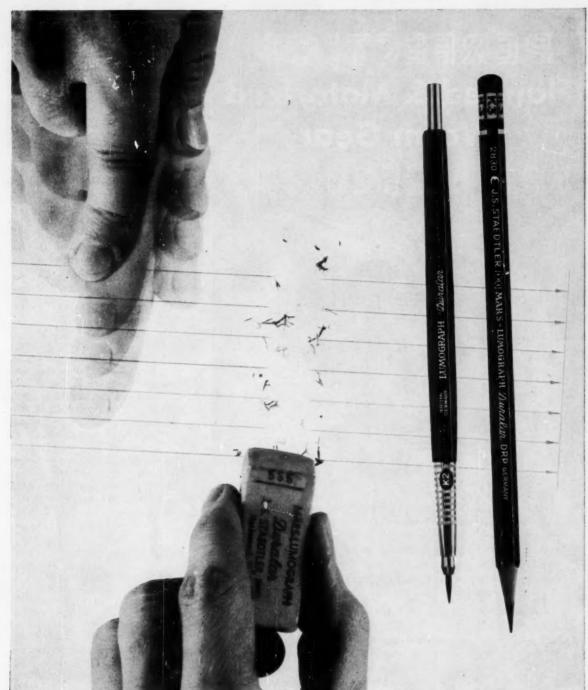






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Perfection Motorized Worm Gear Speed Reducers are available in 956 different combinations, with ratios ranging from 5 to 1 to 60 to 1, and in capacities from 1/6 H.P. to 5 H.P. This line of complete Motorized Reducers is available from stock for immediate delivery. Perfection "C" flange Reducers may be ordered complete with motor or without motor, to be used with a motor of your own choice.

Flanged motor reducers offer the maximum in compactness, rigidity and adaptability. Through the use of standard NEMA face mounted motors, complete interchangeability between motors

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is provided. Motor maintenance is possible without disturbing the drive and reducer. Motor assembly is fast and positive with no alignment problems.

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HARVEY, ILLINOIS



Smaller sprocket has 60 teeth and the larger, 72. Both sprockets use a No. 35 chain. Depth of the entire brake-sprocket assembly is 1½ in. Magneto & Engine Accessories Div., Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

Circle 729 on Page 19

Adhesive Compounds

bind foams to fabrics, paper, metal foil

Adhesive compounds based on acrylic interpolymer latexes bind polyether or polyester foams to various types of textile fabrics, paper, and metal foil. All adhesives are both washfast and solvent-resistant. Recommended heating time and temperature is 3 to 10 min at 280 to 300 F. All adhesives are applied directly to the polyurethane foam by spraying, roller coating, striping, or rotogravure printing procedures. Alco Oil & Chemical Corp., Trenton Ave. & William St., Philadelphia, Pa.

Circle 730 on Page 19

Spiral Nozzles

are nonclogging units with intermediate capacities

TF10 and TF14 series of nonclogging spiral nozzles consist of eight models with pinless spiral design. All are made from one piece of material and give good atomization at low pressures. Nozzles provide capacities of 4 and 8 gpm respectively at 40 psi with wide or narrow





molded of tough, flexible Polyethylene

unaffected by most chemicals

easy to apply . . and remove

won't chip, break, shred, or collapse

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A full family of closures to meet almost any need you can name over 600 sizes in numerous styles and colors now in stock.



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THE EXACT WEIGHT SCALE CO.

923 W. FIFTH AVE., COLUMBUS 8, OHIO In Canada: 5 Six Points Road, Toronto 18, Ont. angle and full or hollow-cone pattern. Each model is available in brass, Type 303 stainless, Teflon, PVC, plastic, or hard rubber. Bete Fog Nozzle Inc., 309 Wells St., Greenfield, Mass.

Circle 731 on Page 19

Vertical Pump-Motor

is dynamically balanced for vibrationless operation

Vertical Hollowshaft pump-motor has application wherever water is to be lifted, distributed, or circulated with centrifugal pumps. All winding are impregnated with varnish, then permanently cemented into a single, solid mass. Heavy-duty insu-



lation on all slot cells, end connections, and flexible leads provides maximum dielectric strength. Longlasting, positive lubrication is provided by grease fittings located for direct feed to each bearing. Dynamic balancing assures vibrationless operation. Motors are available for standard, medium, and heavy-thrust applications, depending upon the distance the water must be lifted. Horsepower ratings are from 1 through 30 in frame sizes 225 through 326U. Reuland Electric Co., Alhambra, Calif.

Circle 732 on Page 19

Adjustable-Speed Drive

features close speed regulation

Class 8833 Type BG adjustable-speed drive includes controller, pushbutton station, and drive motor. Speed range from 2:1 to 100:1 and ratings from 3/4 to 4 hp are provided. Drive operates from a single-phase ac supply. Drive provides short-circuit protection, under voltage and overload protection, a timed method of ac-

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The manufacturer of this pinion gear cuts finished cost 23% by starting with Champion upset forged blanks. He saves on material by using a $1\frac{1}{64}$ " x 5" blank with a $1\frac{3}{4}$ " collar instead of $1\frac{3}{4}$ " bar stock. He saves again because most rough machining is eliminated.

Upset forgings can save you money and give you better quality too . . . upsetting increases strength

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CLEVELAND 5, OHIO . EAST CHICAGO, INDIANA

When it's a vital part, better make it FORGED





celerating to preset speed, regulated speed-reference supply, and tube circuits that are fail-safe on filament burn-out. Square D Co., Dept. SA, 4041 N. Richards St., Milwaukee 12,

Circle 733 on Page 19

Induction Motor

for a variety of military and industrial applications

B-5-1 miniature induction motor is a 1/100-hp unit weighing 7.55 oz. Designed to operate a 21/8-in. diam, four-blade fan utilized to cool electronic equipment, it also serves a variety of military and industrial applications. Totally enclosed unit has an operating speed of 5200 rpm and functions as a continuous-duty motor when equipped with appro-



priate blower. Kearfott Div., General Precision Inc., 1150 McBride Ave., Little Falls, N. J.

Circle 734 on Page 19

Rubber Hose Assembly

for hydraulic applications in 1/4 to 2 in. diam

Rubber hose assembly designed for hydraulic applications incorporates non-skive hose and progressive swaged end fittings for maximum reliability. Sizes available range from 1/4 in. to 2 in. diam, and fittings include male pipe, JIC, and SAE swivel configurations with adaptors to meet other requirements.

Circle 455 on Page 19-May 11, 1961



FOR THINGS FRESH, COLD, HOT, ACCURATE ...

NEW U.S. GAUGE VAPOTHERM THERMOMETERS ARE RIGHT ON TOP

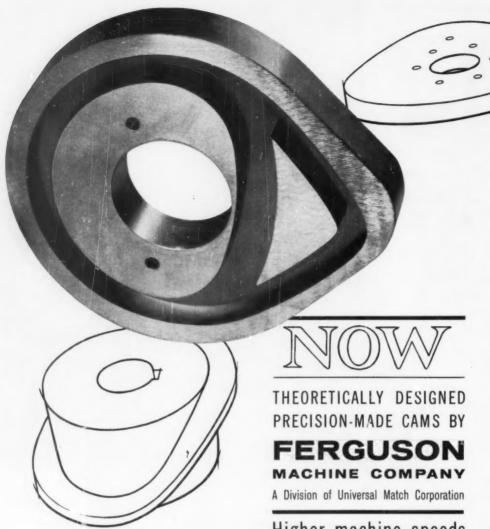
Top protection of perishables is a job U.S. Gauge's new Series 8000 Vapotherm does so well. Wherever precision and dependability count, you will find it effectively at work in applications such as these-and many more:

food display cabinets • dishwashers • cooking vats • water chillers • film developers • refrigerators • incubators • milk coolers • ovens

We have added many make-sure features in this new line. For example, extruded brass sockets insure against leakage for the life of the unit. Accurately generated gear teeth in a newly designed movement will give you smooth operation indefinitely. Bourdon tubes are of phosphor bronze or beryllium copper for greater stability over greater temperature ranges. You can easily pay more and get less than this quality of craftsmanship and materials. Also new, and optional, is a front or rear zero adjustment when intentional offsets are desired. For exactly the right thermometer, you have your pick of over 200,000 combinations of sizes -2", 21/2", 31/2"-heads, bulbs and capillaries in the thermal system. Write for our new catalog sheet No. F-038-070 for full specifications.







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Medium-pressure assemblies are for operating pressures to 3000 psi, and high-pressure units are suitable for pressures to 5000 psi. **Titeflex Inc.**, 603 Hendee St., Springfield 4, Mass.

Circle 735 on Page 19

Wire-Wound Resistor

has sealed resistance element

R-65 Rotohmeter is a two-terminal, precision wire-wound resistor provided with an adjustment feature by which the user himself makes final adjustment to a desired resistance, then seals the unit with epoxy



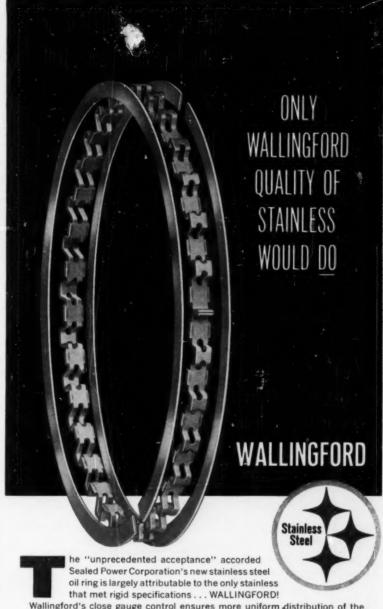
or other sealant. To increase range and resolution, units are available having twin resistance sections, one fixed and the other one adjustable. Adjustment range is 0.001 ohm through 5 megohm. Power rating through 5 w is 125 C. Unit is immune to severe shock, vibration, humidity and/or salt water. Variety of sizes and terminal styles is available. Rotohmeters Inc., 46 Prospect St., Yonkers, N. Y.

Circle 736 on Page 19

Trimming Potentiometer

subminiature unit is for printed-circuit applications

Model 356 Squaretrim subminiature trimming potentiometer for high-temperature applications is furnished in a package $\frac{1}{2}$ x $\frac{1}{2}$ x 0.195 in. deep. Operating-temperature range is from -55 to +200 C, with resistance values provided from 10 ohms to 50 kilohms. Designed with solid-wire leads, unit is especially suited to printed-circuit applications. Trimmer can be used with any



Wallingford's close gauge control ensures more uniform distribution of the stresses in the functioning ring.

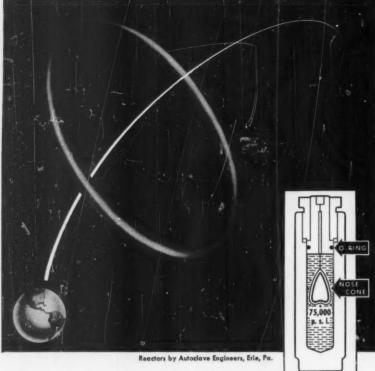
The clean-cut, burr-less edges of Wallingford strip, along with its total freedom from twist and camber—ensure the proper function of the punch press.

The as-rolled physical properties of the strip, and Wallingford's close control of them, contribute vitally to the production and ultimate function of the ring . . . and because Wallingford strip can be held to a precisely specified range of tensile, yield, and hardness, the ring is endowed with "a built-in tension that lasts indefinitely".

If you're a Wallingford customer, you're certain of such quality and performance, always. Exclusive Wallingford fabricating and testing techniques make it so. Ask for specific recommendations on your need for strip and tubing.

Progress in Metals Since 1922





Continental "O" Rings Help Put Satellites in Orbit

Almost as dramatic as the thrust of a satellite into outer space is the technique used to fabricate the nose cone of the missile. These nose cones, made either of powdered metals or refractory materials, are being compacted in 12" I.D. pressure vessels under hydrostatic pressure of 75,000 P.S.I. Imagine the problem involved in sealing a vessel against such terrific pressure!

Yet THAT is the problem solved by this Continental "O" Ring. Obviously an ordinary "O" Ring would not do. The job called for a special compound with molecular formation so precise that separation or micro-leakage just could not occur. Continental developed the compound that meets this rigid test. What's more, the elasticity of the rubber refuses permanent set and thus permits re-use of the ring.

This unusual rubber problem typifies the complete engineering service available to you here at Continental. Whether you need molded or extruded rubber parts, consult with us while your new products are still on the board. Let us suggest how you might save both tooling and material costs—and get a better product for the job.

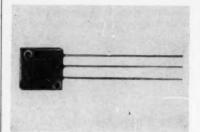
Hydrostatic Pressing (see diagram).

A technique for producing uniform compaction and grain structure to obtain super hardness and impact resistance in critical components. A steel forming-mandrel is coated with a refractory material, placed in a rubber bag and suspended in pressure vessel. Pressure is applied until required density is attained.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.



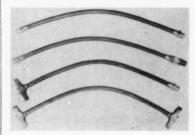


board pattern and mounted in any position. Circular design of the mandrel permits use of a longer resistance winding than conventional trimmers, affording higher resistance values. Power rating is 1 w at temperatures to 50 C, derating to 0 up to 200 C in still air. Potentiometer Div., Daystrom Inc., Archbald, Pa.

Flexible Steam Hose

is corrosionproof and nonaging

Fluoroflex-T (Teflon) hose for steam and other high-temperature liquid applications, comparable in cost to conventional metal hose, is nonaging and corrosionproof. One-piece brass male or JIC swaged fittings eliminate steam leaks by replacing welded fittings. Hose is Fluoroflex-T, covered with either bronze or stainless-steel braid. As a steam line, it is rated to 250 lb pressure. As a general-service line,



rating is to 500 psi and 500 F. It is available in sizes from ½-in. male pipe thread end fitting to 1 in. male pipe thread. Resistoflex Corp., Roseland, N. J.

Circle 738 on Page 19

Time-Delay Relay

is rated 100 ma to 10 amp

Low-cost thermal time-delay relay is available with single-pole, single-

FRICTION-FREE MOTION improves performance, reduces power requirements on Giddings & Lewis Numerically Controlled DiMil

Tychoway recirculating roller bearings (right) are used to provide smooth, controllable, vertical and horizontal

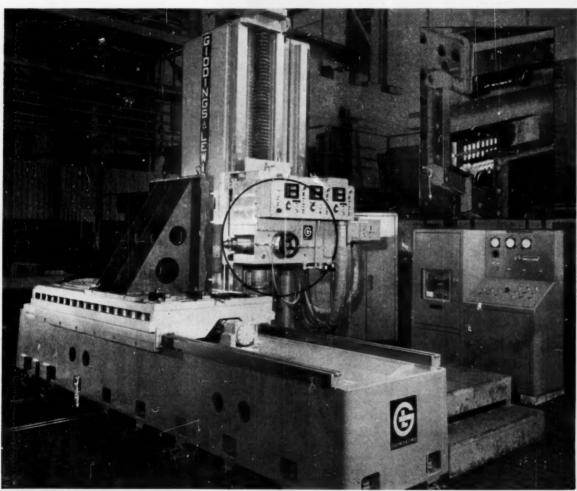
movements of the DiMil head. Complete elimination of stick-slip makes possible actuation by low hp servo motors—assures accurate machining. Rigidity and sensitivity improve cutting characteristics of the machine. Assembly is simpler, too, because there is no hand scraping. / Tychoway bearings open new opportunities for product improvement. Superiority can be measured in accuracy, economy, versatility, and service life . . . as well as in ease of lubrication, power reduction, and elimination of stick-slip. Standard sizes: from 1000 to 32,000-lb static load capacity. Write for Bulletin 22-50.

Special Products Division



Scully-Jones and Company

1905 South Rockwell Street, Chicago 8, Illinois





Nylon has been proven in service

as an outstanding bearing material because of built-in lubrication,

ability to withstand abrasive and

corrosive environments, and mechanical strength. And MC* nylon,

newest of the nylon family, is more

adaptable than any and most

economical of all. Tubular bars,

for example, cost less than other

nylon formulations . . . even less

than continuous cast bronze. Plate

and rod sell at prices under com-

POLYPENCO MC nylon has pre-

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101 with outstanding wear life,

strength and resistance to defor-

mation under load. Typical appli-

cations: rollers, bearings, bushings, gears, cams, forming de-

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TUBULAR BAR: 2"-15" O.D. SOLID ROD: 3"-24" O.D.

LARGE PLATE: 1/4"-6" Thick

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Non-scarring work holder bushings for disc grinding roller bearings.

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5"I.D. x 7" O.D. x 13" long back-up rolls for die cutting outline and patterns of paper place mats and lace doilies save \$2000 per machine in cost of rolls alone replacing Kraft paper rolls.

IN DRIVE ROLLERS



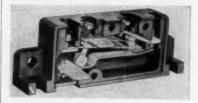
Support rollers for end grinding roller bearings.

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THE POLYMER CORPORATION OF PENNSYLVANIA

Reading, Pennsylvania Engineered Industrial Plastics

EXPORT: Polypenco, Inc., Reading, Pa. STOCK SHAPES . MOLDING RESINS . SINTERED PARTS . WHIRLCLAD® COATINGS



throw, normally open or normally closed contacts, two independent circuits, or single-pole, double-throw. Unit features totally enclosed Bakelite housing, two mounting variations, and terminals to accept either solder or standard quick-connect wiring. Relay is rated 100 ma to 10 amp, up to 115 v ac. E-T-A Products Co., 6285 N. Cicero Ave., Chicago 46, Ill.

Circle 739 on Page 19

Synthetic-Rubber Adhesive

bonds porous materials to metal

Fast-drying, synthetic-rubber adhesive allows parts assembly within 2 to 5 min after application. Bostik 1142 is effective for bonding porous materials such as urethane foam to metal, and is applicable to military specifications MIL-A-1154-A and MIL-A-5092-A, Type II. Material adheres to steel, aluminum, brass, glass, neoprene, GR-S, Buna-N, phenolic, Urea, Polystyrene, glass fiber, felt, cork, Masonite, leather, nylon, sponge urethane, sponge rubber, and enameled surfaces. Three application methods permit flexibility in assembly systems. Bostik Dept., B. B. Chemical Co., 784 Memorial Drive, Cambridge, Mass. Circle 740 on Page 19

Panel Meter

is 4 x 6 rectangular, all-metal unit

All-metal panel meters have steel movement enclosures that protect

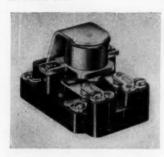


fully against the effects of magnetic panel materials or stray RF. All meters are gasket-sealed to keep moisture, dirt, and foreign particles out. Scale length of the 4 x 6-in. unit is 4.7 in. for maximum visibility and reading ease. Mounting configuration matches other meters of similar size. Standard meter finish is flat black, but bezel is provided in any color. Helipot Div., Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 741 on Page 19

Power Relay

features an inverted coil



Series 2300 power relay features an inverted coil which protects the armature and contacts from electrical and physical malfunctions. DPDT contacts are rated for 15 amp at 115 v ac noninductive, or 1 hp at 115/230 v, 60 cycle. Screwtype terminals can be connected from top or bottom for added flexibility in mounting. Relay is available in voltages of 6, 12, 24, 115, and 230 v ac, and 6, 12, 24, 110, and 220 v dc. Over-all dimensions are 3 5/16 x 2½ x 2 1/16 in. Guardian Electric Mfg. Co., 1550 W. Carroll Ave., Chicago 7, Ill.

Circle 742 on Page 19

Wound-Epoxy Tubing

has high burst strength

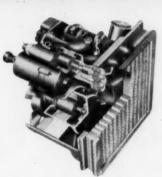
GFW-60 glass-filament wound-epoxy tubing provides a tubing material, with burst-strength properties which exceed those of G-10 grades by about 3 to 1. Manufactured by the use of continuous strands of glass filaments bathed in epoxy resin, helically wound, and then heat cured, tubing makes it possible to achieve exact ratios between burst



Compact Pesco design provides maximum space economy, eliminates external plumbing.

Advanced Pesco axial flow fan design delivers greater air volume . . . quietly and efficiently.

Performance-proven Pesco motor is a precision-built AC or DC unit designed for prolonged trouble-free service.



Reliable Pesco coolant pump offers efficient heat dissipation, greater pumping capacity, minimum plumbing.

Lightweight precision components are perfectly integrated into a rugged shockresistant unit.

Electrodynamic balancing assures quieter, vibrationfree performance, extends service life

MICRO-MATCHED COMPONENTS MINIATURIZED DESIGN CUSTOMIZED TO YOUR REQUIREMENTS

UNIQUE "PACKAGE" CONCEPT

Pesco builds all its components, including the coolant pump, fan, motor and housing . . . plus controlled design of the heat exchanger. This means you get guaranteed performance . . . single source responsibility.

CUSTOM ENGINEERING AND PRODUCTION

Pesco offers complete design-andbuild facilities backed by its own teams of creative engineers plus those of the Borg-Warner Research Center.

WIDE RANGE OF CAPACITIES

These Electronic Coolers are custom designed to operate under severe environmental conditions. Capacities for the popular liquid-to-air systems range from 250 watts (14 btu/min) to 30,000 watts (1700 btu/min) ... temperatures from -65° to 212° F. at altitudes to 70,000 ft.

MILITARY AND INDUSTRIAL APPLICATIONS

Compact Pesco Electronic Coolers are widely used for vital cooling applications in the aerospace, electrical and electronics industries.

FOR NEW CONCEPTS IN COOLING . . . LOOK TO PESCO FOR MINIATURIZED UNITS EMBODYING ADVANCED DESIGN AND PRODUCTION TECHNIQUES FOR FAIL-SAFE PERFORMANCE AND EXTENDED SERVICE LIFE . . .





TYPE K4



Victoprene on O.D. and outer face; patented lead-into-bore feature. Integrally moided element and case.



Steel O.D.—Victoprene gasket on inside face. Primary lip retains lubricant; secondary lip excludes dirt, foreign matter.

PROVEN DESIGN

compact, dual-lip oil seals as narrow as ¼-inch

Victor Victoprene oil seals in two types to accommodate varying installation and bore sealing needs, yet provide identical shaft sealing efficiency in even the most limited housing space.

- DUAL SEALING SURFACES—Inner lip retains fluid; outer lip excludes foreign matter or confines secondary lubricant.
- VICTOPRENE ELEMENT—Developed of improved Buna N synthetic rubber for balanced resistance to lubricants, heat, age deterioration.
- PERMANENT PRE-LUBRICATION— Cavity between lips holds lubrication on installation. Reduces frictional drag; extends seal life.
- NARROW WIDTH—One-piece integral molded construction for most compact seal housing.
- POSITIVE SPRING LOCATION— Molded groove retains spring; uniform pressure on shaft assured. Both types available without spring.
- POSITIVE BORE SEALING—Type K4
 has bonded-to-case Victoprene on O.D.
 and outer face; lead-in allows easy installation. K6 has steel O.D. with integral gasket on inside face for bottom of bore seal.

WRITE FOR CATALOG...

Covers above types and all varieties of Victor oil seals; includes service recommendations. Useful to specifiers and buyers. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, III. Canadian plant: St. Thomas, Ontario.



VICTOR

OIL SEALS • GASKETS • PACKINGS

MECHANICAL SEALS

Circle 462 on Page 19

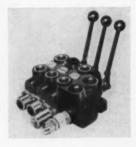
NEW PARTS AND MATERIALS

and tensile strengths to meet requirements of specific applications. Tubing is available in a variety of circular sizes and lengths or in special cross-section shapes. Spaulding Fibre Co. Inc., 310 Wheeler St., Tonawanda, N. Y.

Circle 743 on Page 19

Sectional Valve

in port sizes from 1/2 to 1 in.



Banks of as many as eight sections can be assembled with new sectional valve, with choice of three and fourway, free-flow, or four-position float construction in each section. Handles can be mounted at either end and load checks are provided in all sections. Main relief valve is in left-end section. Port sizes from ½ to 1 in. are available with eight straight (SAE) or tapered (NPTF) threads. Maximum pressure is 2500 psi, and capacity is 35 gpm. Gresen Mfg. Co., 405-35th Ave. NE, Minneapolis 18, Minn.

Circle 744 on Page 19

Limit Stops, Slip Clutches

in Sizes 5 and 8

Miniaturized BuOrd Size 5 and 8 mechanical limit stops, fully adjustable from 0 to 14,400 deg, and complementing precision slip clutches, are now available. Limit stops, designed to conform to MIL-E-5272 C, feature a nonjamming design, low starting torque, and repeatability to within 3 min of arc. Torque rating on the Size 5 is 80 oz-in., and 160 oz-in. on the Size 8. Miniaturized slip clutches utilize Delrin as bearing material and include a Precision Class I, stainless-steel gear in 72, 96, or 120 pitch. Northfield Precision Instrument Corp., Island Park, L. I., N. Y.

Circle 745 on Page 19



Ashland's enviable reputation as a leader in the field of design and manufacture of air moving equipment stems from many years of meeting critical engineering specifications for military, airborne, electronics and other industrial applications.

Blowers and fans of innumerable combinations of pressure and volume have been developed at Ashland.



Ashland units are engineered and manufactured to your precise specification—at no additional premium. Inquiries concerning the design and delivery of Blowers, Fans, and Motors are welcome. For descriptive catalog or quotation on specific production problems, write, wire or call.

ASHLAND

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ENGINEERING DEPARTMENT

EQUIPMENT

Weldable Strain Gage

can be attached to aluminum alloys

AL-E weldable strain gage which can be attached to almost all aluminum alloys operates at temperatures equal to the deterioration point of aluminum itself. Nominal gage factor for unit is 1.75. Gage is 3/16 in. wide and either 1 5/32 or 9/16 in. long. Both 60 and 120-ohm gages are available, and



all types can be temperature-compensated inherently for aluminum alloys. Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.

Self-Contained Photocopier

uses premixed developer in disposable cartridge

Transamatic I incorporates a disposable cartridge, using completely premixed developer. Cartridge snaps into place and snaps out when solution is used up. Tray automatically fills when the machine is turned on and developer returns to the cartridge for storage when the machine is turned off. Paper-safes built into the base of the unit guard paper from light exposure. Unit reproduces copy in 11 sec, in black on white paper or on a variety of colored papers. It picks up everything on the original, whether written, typed, printed, or drawn, whatever the original

MEEHANITE MEANS BETTER CASTINGS®





New AQ Meehanite® Air Hardens....No Distortion

This new wear and abrasion resisting type of Meehanite® is a low cost metal of extremely high hardenability that offers many performance and cost advantages. It is recommended for critical castings of varying section size that require a Brinell hardness over 400 and which must retain accurate dimensions.

Such castings, made in type AQ Meehanite which has an "as cast" hardness up to 280, can be machined first, if necessary, and then safely air hardened without the risk of cracking or distortion associated with water or oil quenching. Final hardness — up to 500 Brinell; tensile strength — 66,000 psi.

AQ Meehanite® can easily be locally hardened for improved wear resistance of working faces and edges of such parts as dies, punches, cams, sheaves, etc. Another advantage is that the hardness at elevated temperatures is considerably better than most engineering materials. Also, AQ Meehanite, because of its manganese content, exhibits considerable work hardening during service.

For more information about AQ Meehanite®, send for your free copy of our 4-page folder, B-48. Write to Meehanite Metal Corporation, 714 North Avenue, New Rochelle, New York.



MEEHANITE METAL

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES.



no other metal has the combination of properties found in new HAVAR

Designers looking for a new and versatile metal are finding practical answers in the unique properties of Havar. This unusual material is a corrosion-resistant, non-magnetic alloy with high fatigue resistance and high tensile strength. It possesses exceptionally high resistance to permanent deformation, thus permitting a more constant delivery of torque over extended periods.

New Havar is being used for critical springs and process control diaphragms, torque control drive bands, electronic computers and—because of its ductility and corrosion resistance—for orthodontic wire.

Havar was developed by the Metals and Electronics Division of Hamilton Watch Company. It is presently available in bars, wire, strip and in foil in thicknesses down to 0.0001" at tolerances closer than you can imagine.

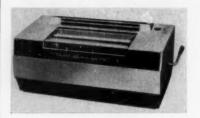
Write today for complete data on engineering properties and processing instructions. Ask for the Havar Technical Data Sheet—or for a sample of Havar. Dept. MD-5.

HAMILTON

WATCH COMPANY / Metals and Electronics Division

H.

Lancaster, Pennsylvania



colors. Unit operates from standard electric outlets. Transcopy Inc., 10 Paterson Ave., Newton, N. J.

Circle 747 on Page 19

Circle 748 on Page 19

Tinted Sensitive Papers

maintain color and have high shelf life

Wide variety of tinted sensitive papers is available for Ozalid dry and Ozafax semidry (moist developing) diazo-printing process. Base colors of semidry papers are blue, green, pink, salmon, buff, and yellow. Black-lined, they offer clean backgrounds and maximum contrast. Dry-developing papers are blue, pink, green, and yellow, with black, blue, or red images. Papers keep their color for life, and will not wash out. Ozalid Div., General Aniline & Film Corp., 514 Corliss Lane, Johnson City, N. Y.

Miniature Slip Ring

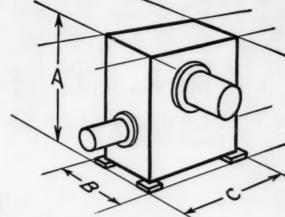
has manually operated brush lifter

Applications for Model SR 10M sealed, ten-circuit, miniature slipring include strain gage, thermocouple, and vibration measurements on automotive and aircraft engines, wheels, and similar rotating parts. Slipring, 2 in. OD by 15% in. long, is sealed for operation in the presence of oil, water, dust, and other contaminants. Manual rotation of the brush lifter about 90 deg raises



MACHINE DESIGN

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You

can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

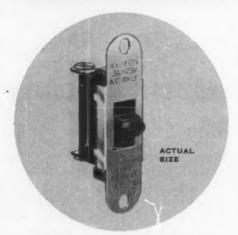
Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

NEW

SWITCH



PLANNED PERFECTION RUGGED • COMPACT DEPENDABLE

Circle F announces a new, high reliability slide switch. A product of advanced engineering techniques, this new switch features silver alloy contacts and silver plated rockers, with the entire mechanism enclosed in a dust free, Hi-Impact thermosetting plastic case

Slow make — Slow break precision operation Specially designed non-welding contacts

This built-in ruggedness provides the long-lasting dependable service so typical of Circle F products

The new Switch — SPST — is available with screw terminals or with lugs designed for both soldering and push-on tabs

It offers 2 hole mounting \bullet 10 amp 250V A-C -15 amp 125V A-C

• 3 amp 250V A-C - 6 amp 125V A-C

Special ratings on request



CIRCLE F MFG. CO.

ENGINEERING DEPT. EQUIPMENT

the brushes from the slip rings when measurements are not being made. Ring is encased in stainless steel with permanently lubricated bearings. Solder terminals on the rotor and stator are color coded. Noise is insignificant at speeds to 6000 rpm. Michigan Scientific Corp., 730 Bellevue, Milford, Mich.

Engineer's Notebook

permits keeping of complete records in one location

Tech-Form notebook contains 50 graph sheets, 50 tracing sheets, 10 data sheets, and three index pages. It permits records from idea conception to completion to be kept in the same place, prevents records, notes, or sketches from being lost.

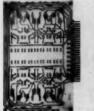


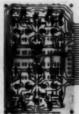
Blueprints, photostats, and other copies can be made directly from tear-out sheets without disturbing original work. Book is plastic-bound, size 8½ x 11 in. Tech-Form Co., Div., Martin Sweets Co., 114 S. First St., Louisville, Ky.

permit development of a variety of circuits

Transistor Cards

All-purpose cards for transistor circuits are available for breadboarding semiconductor circuits and fabrication of prototype instruments and systems. E-Z Circuit Cards bridge the gap between preliminary schematic drawings and production-type printed circuit boards. Wide variety of analog and digital circuits can be developed by inserting active and passive components, using predrilled holes provided. In most cases, only a small amount of





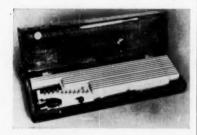
point-to-point wiring is required to achieve the desired circuit function. Cards hold eight complete transistor circuits. They are $4\frac{1}{2} \times 6\frac{1}{2}$ in. size, with a standard 28-contact connector along one side. Circuit Structures Lab., P. O. Box 1194, Santa Ana, Calif.

Circle 751 on Page 19

Lettering Set

consists of 12 templates, scriber, and pen

Made of three layers of flexible material to prevent warping and distortion, templates in new Unitech lettering set have a scaling guide for centering. Twelve templates have Gothic letters and numerals, in sizes from 0.06 to 1 in high. Each letter is engraved complete to eliminate shifting. Scriber can be adjusted for vertical or slanting letters. Pen, consisting of tube and pin, works by capillary action to control even flow of ink and uniform lines. Five assortments of



sets, each in polished wooden box, are available. Unitech Corp., 50 Colfax Ave., Clifton, N. J.

Circle 752 on Page 19

Breadboarding System

for circuit design

Time-saving breadboarding system features new Koil-Klip, a connector using helical-spring design. Transistors, diodes, and other subminia-

Circle 468 on Page 19→



when buying custom molded plastics

The unit cost of a molded plastic part does NOT tell the entire story . . . nor should it be the sole factor in your selection of a custom plastic molder.

Specifying Aico-molded plastics not only assures you of a reasonable unit cost, but will provide a priceless bonus in Aico's fully integrated molding service . . . a service that eliminates split responsi-

bilities and assures delivery deadlines that are respected.

AICO offers all users of custom molded plastics a completely dependable service with unmatched experience and coordinated facilities for Engineering, Mold Building, Compression, Transfer, Plunger, Injection and Cold Molding...plus the molding of Reinforced Fiberglass.

look to AICO for custom molded plastics





BEARIUM METAL'S amazing superiority is due to the uniform dispersion of microscopic lead particles within the copper-tin grains rather than between the grain boundaries as found in ordinary bronzes. Result is that it will not seize or score the shaft nor will it melt out like babbitt—even in applications where a liquid other than oil must be used as the lubricant.

If you have a bearing application calling for dependable, trouble-free performance, by all means BEARIUM METAL is your best buy in bearing bronze. Try it on one of your toughest jobs. You'll be glad you did!









Bearium Meta

Ordinary

FEATURES: Non-Seizing and Non-Scoring * Long-Wearing * Self-Lubricating * Low Coefficient of Friction * Nigh Compressive Strength * Resistant to Shock Loads * Sound, Uniform Structure. AVAILABLE IN: cored and solid bars, centerless ground rods, machined parts, pattern castings.

Write for the BEARIUM METAL story.

BEARIUM METALS CORP.

192 Mill St., ROCHESTER 14, N. Y.

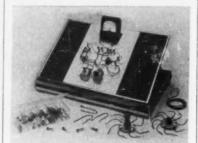
West Coast Affiliate:

NEVIN ENGINEERING ASSOCIATES PACIFIC PALISADES, CALIF.

In Canada:

BEARIUM METALS OF CANADA, LTD.
RICHMOND HILL, ONT.

Circle 470 on Page 19



ture components which are easily damaged due to soldering are suited to the Koil-Klip connector. Connector accommodates leads of the foil-type as well as leads having diameters to 0.050 in. Model K-100 system is packaged in a carrying case, complete with Koil-Klips, tube and transistor socket adaptors, potentiometer and switch adaptors, and a supply of hardware. Electraid, P. O. Box 53, Cambridge 41, Mass.

Circle 753 on Page 19

Laboratory Furnaces

heat to 2300 F

Dyna-Trol furnaces are small, compact units which heat up to 2000 F in 1 hr and 2300 F in 1½ hr. Constant level of temperature, from 300 to 2300 F, can be maintained by means of input controllers which can be set at 7 to 100 per cent of input. Elements are supported by Dyna-Glow element holders which provide good heat transfer properties. Four models are available. Models P46 and P46H are 4½ in. wide, 4½ in. high, 6 in. deep; Models P76 and P76H are 6 in. wide, 6 in. high, 6 in. deep. Each



unit can be equipped with forcedconvection fans to assure an antomatic and even gradient in the furnace at any point along the heat curve. Fan operates to temperatures of 1875 F, and can be removed

TIPS

AND

TECHZ-QUES

VOLUME II ENGINEERING AIDS

- Simplifying Constructions
- Utilizing the Slide Rule
- Construction Aids
- Shortcuts for the Engineer

Helpful Tips and Techniques that apply to engineering methods, are now available in this one-volume reference. This manual contains 32 pages of illustrated time-and-money saving procedures that every engineer

\$1.00 a copy

Order from

MACHINE DESIGN

Reader Service Penton Building Cleveland 13, Ohio

(Remittance or Company Purchase Order must be enclosed with order) easily for operation above this point. L & L Mfg. Co., 806 Mulberry St., Upland, Chester, Pa.

Circle 754 on Page 19

Pressure Transducer

for temperatures from -54 to +85 C

Miniature pressure transducer, Model 451218, features over-all accuracy of ±1 per cent at room temperature and ±2.5 per cent at temperature extremes; resistance to rugged environments; and a variety of pressure ranges, pressure modes, electrical connections, and mounting arrangements. It is suitable for single or multimodel installation for inflight surface-pressure meas-



urement, missile and space vehicle telemetering, aircraft altitude sensing, and aircraft pitch and yaw control. Ranges available are 0 to 10 to 0 to 150 psia, psig, or psid. Temperature range is -54 to +85 C. Unit weighs 1 oz and is 1 cu in. size. Giannini Controls Corp., 1600 S. Mountain Ave., Duarte, Calif.

Oscilloscope Bay

consists of seven transistorized units

Model 260 oscilloscope bay provides seven 2-in. transistorized monitor oscilloscopes in a standard $3\frac{1}{2}$ x 19-in. rack mount. Each plug-in oscilloscope module has independent sweep and vertical circuits. Construction and all solid-state circuit make the bay suitable for monitoring applications in data acquisition, telemetering or control systems, or wherever a high-performance, rackmounted oscilloscope is required in laboratory, field, or airborne applications. Frequency response is de



OUTHEATS—because Watlow's FIREROD® produces up to eight times as much heat as any standard cartridge unit—or will give as much heat as a standard unit in ½th the space.

OUTLASTS—Watlow perfected the exclusive construction techniques that permits the FIREROD® to operate at lower internal temperatures. Better heat transfer from the resistance wire to the sheath permits high operating temperatures without excessive internal temperatures which cause burnouts. Laboratory and field tests have proven FIREROD'S® superiority when tested with any other cartridge heater, including competitive so called "high watts density" units.

OUTPERFORMS_Proven longer life—less replacements and

down time—up to 8 times as much heat as other standard units or the same heat in 1/sth the space—and at a price only slightly higher than a standard unit. Deliveries two weeks or less.

WHEN YOU SPECIFY CARTRIDGE HEATERS SPECIFY WATLOW'S FIREROD

Bulletin 367 will give you complete information.



WATLOW

1384 Ferguson Ave. /St. Louis 14, Mo.

4102



put power where you want it

Flexible shafts give the designer important new freedom in transmitting rotary power or control between two points. They enable you to position your power source and your driven part to best advantage . . . without worrying about obstructions, vibration, shock or alignment.

Even if the components are in relative motion to each other, you can still transmit power smoothly and economically.

Flexible shafts also reduce manufacturing costs . . . use fewer parts . . . eliminate cumbersome gears, drives, couplings, universals. With rigid connections gone, alignment and tolerance problems fade away, and installation is a snap.

Whatever your rotary transmission problem, there is a good chance that one of S. S. White's flexible shaft lines can solve it... Standard, Pre-Engineered, or Custom-Designed flexible shafts.

S. S. WHITE INDUSTRIAL DIVISION, DEPT. 4 10 East 40th Street, N. Y. 17, N. Y.





to 1 mc within 3 db. Electro Instruments Inc., 8611 Balboa Ave., San Diego 11, Calif.

Circle 756 on Page 19

Table-Model Whiteprinter

operates at speeds to 55 linear fpm

Starlet 60 dry-diazo whiteprinter is especially designed for office copying, and for engineering blueprints up to 20 in. wide by any length. Unit operates at speeds up to 55 linear fpm. Over-all dimensions of the printer are 281/8 in. high and 40 in. wide. With feeding leaf, depth of machine is 411/4 in. Machine operates on 110 or 220 v. By simultaneously feeding two lettersize sheets side by side into the machine, production can be doubled. Unit makes sharp, permanent copies while operating continuously at top speed. Paragon-Revolute Div., Charles Bruning Co. Inc., 1800 W. Central Rd., Mount Prospect, Ill.

Circle 757 on Page 19

Freezing Unit

for temperatures as low as -200 F

Cryostor freezer, featuring an adjustable temperature-range control, is suited for laboratory use wherever low-temperature storage or quick freezing is required. A 11/2-cu ft capacity is available for temperatures as low as 200 F. Vapor-proof cabinet is heavy-duty steel, insulated with glass fiber. Hard-rubber, double-lid doors are centered on top of the unit. System consists of two hermetically sealed compressors set up in a two-stage system. Air-cooled unit has fan motor permanently lubricated. Instrumentation Associates, 17 W. 60th St., New York 23, N. Y.

Circle 758 on Page 19

THE ENGINEER'S

Library

Recent Books

Mechanical Measurements. By Thomas G. Beckwith and N. Lewis Buck; 559 pages, 6 by 9 in., clothbound; published by Addison-Wesley Publishing Co., Reading, Mass.; available from Machine Design; \$8.75 per copy postpaid.

The first of two parts discusses the fundamental theory of measurement including basic standards, characteristics of dynamic signals, basic detector-transducer elements, and modifying systems such as input circuitry, resonant circuits, and telemetry. Terminating devices and methods are presented on meter indicators, mechanical and electronic counters, and cathode-ray oscilloscope. The second part treats applied mechanical measurement. Separate chapters cover determination of count, events per unit of time, displacement and dimensional measurement with gage blocks and surface plates, pressure, flow and temperature measurement, vibration and acceleration, and the application of radioactive isotopes.

Engineering Drawing and Geometry, Second Edition. By Randolph P. Hoelscher and Clifford H. Springer; 628 pages, 10 by 8 in., clothbound; published by John Wiley & Sons Inc., 440 Park Avenue South, New York 16, N. Y.; available from Machine Design; \$8.95 per copy postpaid.

The elements of engineering drawing are presented, including geometrical constructions, orthographic projection, sectional views, dimensioning, and material specification. In addition, other parts cover fundamental descriptive geometry, graphical computation, and geometry of advanced projection systems including intersections and developments, axonometric projection, oblique projection and perspective. The section on graphic computation discusses charts and diagrams, vector analysis, layouts for empirical equations, and con-

American Motors Corporation
Armstrong Cork Company
"Bendix Products Division—
The Bendix Corporation"
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struction and use of nomographs. Professional applications are given for map, architectural, structural, pipe, welding, and patent-office drawing.

Dictionary of Mechanical Engineering. By Alfred Del Vecchio, director of mechanical engineering, Manhattan College; 346 pages, 6½ by 9½ in., clothbound; published by Philosophical Library Inc., 15 East 40th St., New York 16, N. Y.; available from Machine Design, \$6.00 per copy postpaid.

Prime definitions in the fields of engineering mechanics, automatic controls, fuels and combustion, and power plants are presented. Definitions of terms directly related to mechanical engineering, but properly in the fields of basic electricity and mathematics, heat treatment of metals, and welding, are included.

Analysis of Flat Plates by the Algebraic Carry-Over Method. By Jan J. Tuma, Kerry S. Havner and Samuel E. French; two volumes, 218 and 49 pages respectively, 8½ by 11 in., paperbound; published by Office of Engineering Research, Oklahoma State University, Stillwater, Oklahoma; \$4.00 and \$2.50, respectively.

The first volume presents a general analysis of thin, simply supported rectangular plates of constant thickness by the algebraic carryover method. Lagrange's fourthorder partial-differential equation of the thin plate is replaced by two second-order equations in terms of loads, moments, and deflections. The numerical evaluations of the algebraic results for plates of various length-width ratio were electronically computed. The final values are recorded in tabular form in the second volume.

Kinetics, Equilibria and Performance of High Temperature Systems. Edited by Gilbert S. Balm and Edward E. Zukoski; 255 pages, 6½ by 10 in., clothbound; published by Butterworth Inc., 7235 Wisconsin Ave., Washington 14, D. C.; available from Machine Design, \$12.50 per copy postpaid.

This volume constitutes the unclassified proceedings of the Conference on Kinetics, Equilibria, and Performance of High Temperature Systems held by the Combustion





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Institute on November 2-5, 1959. Thirty-three papers are presented on standard engine performance parameters, combustor and exhaust nozzle design, input and output thermodynamic data, performance calculations, and computer programing for output thermodynamic data.

Creativeness for Engineers. By Donald S. Pearson, The Pennsylvania State University; 159 pages, 5¾ by 8¾ in., cloth-bound; published by Donald S. Pearson, P. O. Box 413, State College, Pa.; \$4.25 per copy.

A creative approach to interpretation and solution of engineering problems is presented. First, problem recognition, definition, and initial evaluation are discussed. Then, synthesis, analysis, and final interpretation are covered. Scope of illustrative examples has been enlarged in this fourth edition.

Science Since Babylon. By Derek J. de Solla Price, 51/4 by 81/2 in., clothbound; published by Yale University Press, New Haven, Conn.; \$4.50 per copy.

This informative analysis on the roots of our scientific civilization also defines its present structure. The significant events, discoveries and inventions that contributed to America's technological expansion during the nineteenth century are traced from the Renaissance period. In conclusion, the author discusses the relationship between science and the humanities as it affects our probable future.

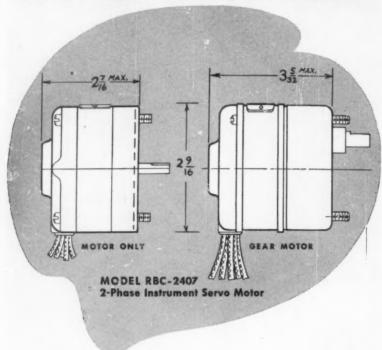
Seventh National Symposium on Reliability and Quality Control in Electronics. 538 pages, 8½ by 11 in., paperbound; published by Institute of Radio Engineers Inc., 1 East 79th St., New York 21, N. Y.; \$5.00 per copy.

A broad survey of reliability and quality control in electronics is presented in 55 papers. Statistical techniques, reliability management, models and mathematics, accelerated testing, system reliability, cost considerations, design techniques, and reliability prediction and programing are the general subjects covered. Specific topics include discrete distributions associated with life testing, reliability of parallel



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Silicones. Edited by S. Fordham; 252 pages, 5½ by 8½ in., clothbound; published by Philosophical Library Inc., 15 East 40th St., New York 16, N. Y.; available from Machine Design, \$10.00 per copy postpaid.

A condensed account of organosilicon chemistry is given in the first part of the book to give a general understanding of the field. The second part is an outline of the industrial manufacture and application of silicones covering fluids, lubricants, rubbers, and resins. Electrical properties are also discussed.

Government Publications

NASA Technical Notes. Copies of publications listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

PB 161907. Fundamentals of Solid Rocket Propulsion. By Henry Tao-Sze Hsia; 44 pages, 8 by 10½ in., paperbound, side-stapled; \$1.25

per copy.

Basic theories and equations in dynamics and thermodynamics of solid-propellant rocket propulsion are presented. A glossary of terms commonly used in solid-propellant rocketry is

PB 161821. Solid Tantalum Capacitors, By Albert Tunchick; 14 pages. 8 by 10½ in., pape-bound, side stapled; 8.50 per copy. This is a study of the properties of the recently developed solid tantalum capacitors. Capabilities and limitations of the capacitor with respect to operating temperatures, electrical lenkage, dissipation factors, stability, and life have been explored and are summarized and illustrated.

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

TN D-725. Factors in Evaluating Patigue Life of Structural Parts. By Walter Ilig; 12 pages, 8 by 10½ in., paperbound, side-stapled; \$.50 per copy.

Three facets of fatigue testing are discussed in relation to problems involved in evaluating fatigue life of structural parts. These factors are variable-amplitude loading, fatigue-crack propagation, and equivalent fatigue loading. Experimental test results are included to support conclusions.

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TN D-526. Correlation of the Buckling Strength of Pressurized Cylinders in Compression or Bending with Structural Parameters. By James P. Peterson, Langley Research Center; 21 pages, 7% by 10% in., paperbound, side-stapled; \$0.75 per copy.

Data on nonpressurized cylinders in compression and bending are correlated with structural parameters. Correlations are made by using small-deflection buckling theory and reduced values for extensional stiffness of the cylinder wall.

cylinder wall.

TN D-714. Analysis of Effective Thermal Conductivities of Honeycomb-Core and Corrugated-Core Sandwich Panels. By Robert T. Swann and Claud M. Pittman. 82 pages, 7% by 10% in., paperbound; \$1.75 per copy.

Equations are derived for the transfer of heat in sandwich panels. An exact method is developed for considering internal reflections of radiant heat and for reducing the given problem to an equivalent problem which may be solved by well-established black-body methods. The effective thermal conductivities are given as functions of the geometric parameters and material properties.



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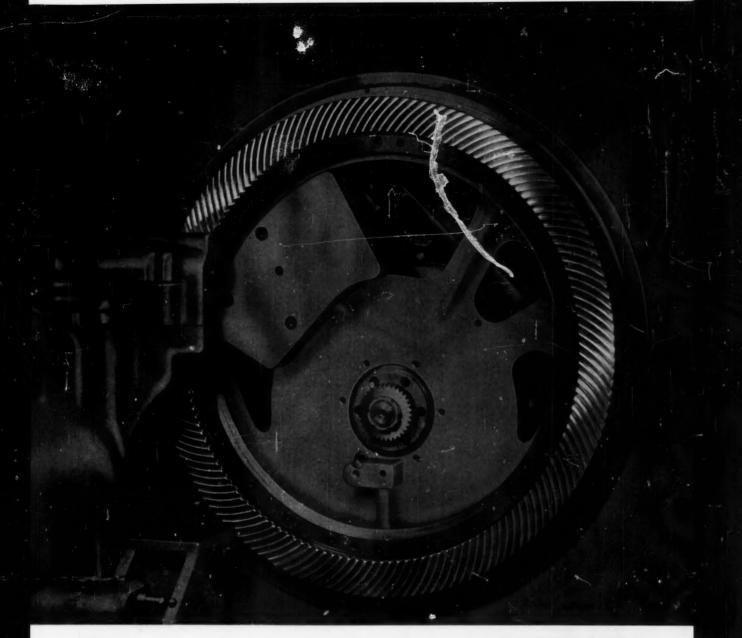
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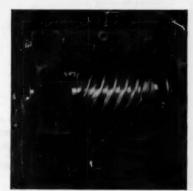
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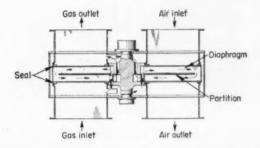
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NOTEWORTHY

Patents

Thermal-Compensated Rotor

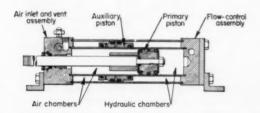
Internal ducts direct flow of hot gas within a regenerative heat-exchanger rotor to prevent thermal deformation. Hollow members are divided into axially spaced passageways by partitions extending from the rotor post radially outward. The hollow members are connected by annular cavities in the rotor post to the gas inlet and outlet ducts. Gas flows to the upper duct



first and then out through the lower duct. Since the gas in the upper duct of the rotor is substantially the same temperature as that at the gas inlet the temperature gradient between the hot and cold ends of the rotor is substantially reduced. The rotor therefore remains flat and the sealing clearances constant. Patent 2,977,096 assigned to The Air Preheater Corp., New York, N. Y., by Ted C. Evans.

Hydraulically Stabilized Air Cylinder

The stroke of an air-operated drive cylinder is stabilized by an auxiliary hydraulic piston and associated control valve. Air admitted to the left end of the outer



cylinder forces the hydraulic piston to the right, at a rate determined by the control valve opening. The hydraulic fluid then flowing into the right side of the



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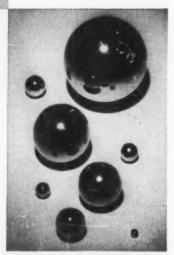
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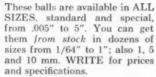
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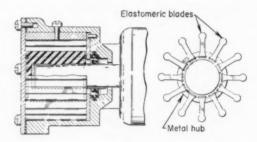
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NOTEWORTHY PATENTS

inner cylinder forces the primary piston to the left. Motion of the drive shaft is fixed by the setting of the flow control valve. The drive shaft is retracted by admitting air to the left side of the inner cylinder and simultaneously venting the left end of the outer cylinder. Patent 2,976,845 assigned to Modernair Corp., San Leandro, Calif., by John E. Goldring.

Pump-Impeller Assembly

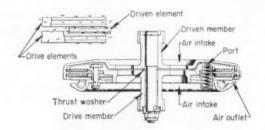
Elastomeric vanes in a pump impeller are joined to a metal or plastic hub to provide a torque-transmitting connection with the shaft. The vanes are attached to the hub by dovetailing for ease of assembly and dis-



assembly. O-ring seals, which block fluid communication between the intervane spaces, prevent the hub ends from wearing against the chamber walls. Patent 2,976,-811 assigned to Jabsco Pump Co., Burbank, Calif., by Frank H. P. Sully.

Air-Cooled Centrifugal Clutch

The friction elements in a clutch are air cooled by pumping action resulting from the centrifugal force of rotation. The webs of the driving and driven members are provided with openings, near the hub, through

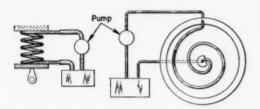


which the cooling air may enter. From the inlet, air flows through a passageway between the members, then through a port to the spring cavities, and radially outward through axial spaces provided in the clutch elements. Air escapes from the clutch through clearances between the outer periphery of the elements and an adjoining flange. Additional cooling is achieved by propelling air radially outward over the external sur-

faces of the clutch members. Patent 2,976,975 assigned to Salsbury Corp., Los Angeles, Calif., by Lewis D. Thostenson.

Liquid-Cooled Springs

Compression or torsion springs are formed from highcarbon steel tubing to permit circulation of cooling fluid for operation at high temperatures. One end of the spring is connected to the delivery side of a pump

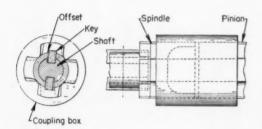


while the other end is connected to a reservoir of cooling fluid which may be a liquid or gas. The springs are first wound, then hardened and tempered, and cold set. Patent 2,977,109 assigned to Associated Spring Corp., Bristol, Conn., by John B. Beckwith.

Limit-control mechanism is reset by a minimum of reverse motion on a cable winch. An intermittent coupling (Geneva wheel) is employed between the drum control and limit switch to permit the lowering of a cable after it has been raised a short distance above its lower limit. Patent 2,973,412 assigned to Breeze Corp., Union, N. J., by Francis M. Joseph and Edgar R. Herrmann.

Quick-Disconnect Shaft

Two opposed keys, mounted in slightly offset keyways, provide a quick-disconnect shaft coupling. The coupling box has a central aperture of cruciform shape



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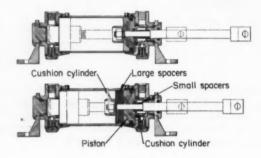
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NOTEWORTHY PATENTS

from moving axially on the spindle and pinion during counterclockwise rotation. To disassemble the coupling, the shaft is rotated in a clockwise direction until the cruciform portions are in alignment. The coupling box may then be slid axially onto the shaft. Patent 2,976,702 assigned to Union Tank Car Co., Chicago, Ill., by Leonard C. Pietsch.

Adjustable-Stroke Piston Rod

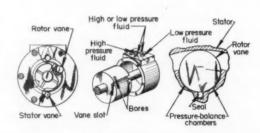
A series of large and small spacers are added to or removed from a piston assembly to adjust stroke length. Since the end of the piston rod is of reduced diameter the piston may be set at any longitudinal position along its length. When a number of the larger spacers



are added at the end of the piston rod, the piston can in effect be made longer. This lengthening will, accordingly, reduce the cylinder stroke. The smaller spacers are used to fill in the space on the opposite side of the piston. Patent 2,976,844 assigned to Modernair Corp., San Leandro. Calif., by John E. Goldring.

Pressure-Balanced Vane Pump

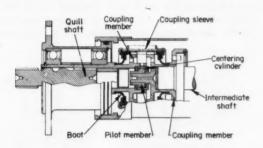
Cylindrical vanes in a rotary actuator are housed in slots provided with pressure-balance chambers to reduce friction and possible binding. With rotation in



either direction, the high-pressure fluid enters the upstream side pressure-balance chamber. This pressure is limited to an arc of about 180 deg by a seal located at the base of the vane slot. Thus, the tangential working force is exerted almost normal to the downstream bearing shoulder. The load bearing shoulder in turn directs the resultant force with enough radial component to balance out any unwanted radial component from the seal member. This assembly prevents high-pressure fluid from getting under the vane to force it outward against the stator wall with resultant binding. Patent 2,975,766 assigned to Kelsey-Hayes Co., Los Angeles, Calif., by Augustus P. Henry.

Compound-Action Flexible Coupling

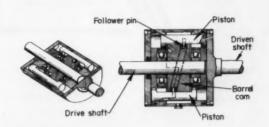
A pilot cylinder located midway between two externally splined coupling members "halves" tooth misalignment with an internally splined coupling sleeve.



One coupling member has internal spline teeth, which mesh with the pilot cylinder, and external spline teeth, which mesh with the coupling sleeve. coupling member is similarly meshed with the coupling sleeve and joined to the pilot cylinder by a stub extension. With this pilot arrangement, the degree of misalignment, as compared to conventional assemblies, is halved, thereby reducing the torsional loading on the quill shaft from angular misalignment. Patent 2,975,620 assigned to General Electric Co., by Eugene E. Shipley.

Piston-Pump Torque Converter

A torque converter comprises a piston pump which automatically declutches at idle speeds. The casing is directly connected to the driven shaft and encloses



the rotating drive shaft. As the pistons are reciprocated by a barrel cam attached to the drive shaft, fluid flow is confined within the casing by a restricted porting arrangement. As the speed of the drive shaft increases

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sion, 9105 Dean St., Lancaster, Pa., or from Eastman Chemical Products, Inc., Dept. M-5, Kingsport, Tenn.

Here are the types of bonds that can be made with Eastman 910 Adhesive

Among the stronger: Natural rubber, SBR, Buna N, most types of neoprene, steel, aluminum, brass, copper, most woods, vinyls, phenolics, cellulosics, polyesters, polyurethanes, and nylon. Among the weaker: polystyrene, polyethylene and fluoro-hydrocarbon plastics (sheer strengths up to 150 lbs./in.3).



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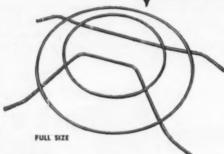
The use of Easiman 910 Adhesive is not suggested at temperatures above 175°F., or in the presence of extreme moisture for prolonged periods.

See Sweet's 1961 Product Design File 10d/Ea.



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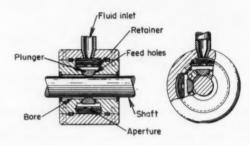
65 CLINTON STREET, BINGHAMTON, NEW YORK

NOTEWORTHY PATENTS

the volume of fluid circulated within the casing also increases until a point is reached where, because of the restricted flow, a torque is developed to rotate the casing with the drive shaft. Patent 2,976,973 assigned to Carney-Stansfield Co., by Hamill Stansfield and James Edge.

Self-Adjusting Hydrostatic Bearing

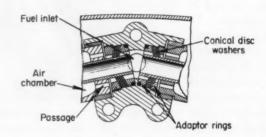
Fluid pressures at various points in a hydrostatic bearing are automatically adjusted according to shaft load. A number of radial feed holes, spaced in the bearing housing, are fitted with plungers which act as control valves. Since the shaft is in continuous contact with the plungers, the position of the shaft deter-



mines the individual clearances between the plungers and holes. Thus, a change in shaft load and position causes an instantaneous reaction by each plunger, changing the fluid pressure in each region and maintaining the shaft centered in the bearing. Patent 2,976,087 assigned to Fairchild Engine and Airplane Corp., Hagerstown, Md., by Justin Cherubim.

Gas-Pressurized Fluid Seal

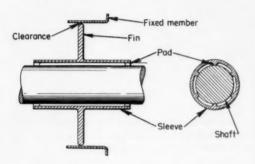
Conical-seal washers are distorted by differential pressure to provide a liquid-tight seal. The washers are held in position by adaptor rings at each end. The



inner peripheries of the adaptor rings are undercut to permit pressurized gas (air) to act directly against one side of the washers and liquid (fuel) against the other side. The pressure differential between the highpressure gas and low-pressure liquid forces the discs toward a straightened position to grip the sealing surfaces. Patent 2,976,065 assigned to Thompson Ramo Wooldridge Inc., by Melville F. Alexander.

Compensating Seal Mounting

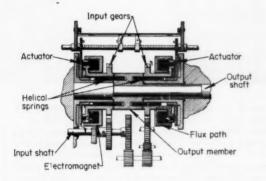
In a seal for high-temperature application, a rotating fin of small thermal mass is mounted on a shaft of large thermal mass. Concentricity between the two is maintained by a distorted sleeve. When extreme and sudden differential temperature ranges are encountered, the rotating fin expands faster than the shaft which carries it. Since the fin is attached to the central portion of



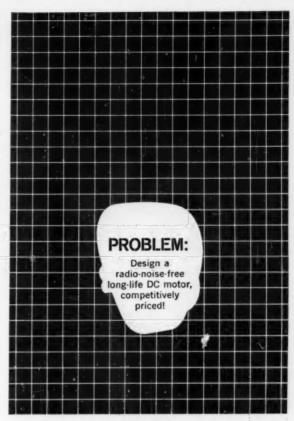
an elongated sleeve, supported by a number of shrunk fit pads, an axial gap is provided between the shaft and sleeve. Expansion of the shaft distorts the sleeve ends into polygonal shape for some distance along the sleeve. However, the central portion which mounts the fin is unaffected and will remain round. Patent 2,977,142 assigned to General Electric Co., by Joseph Savage Alford.

Reversing Spring Clutch

Two helical clutch springs are electromagnetically controlled to change the direction of output rotation. Input gears are rotated in opposite directions at con-



stant speed by a single power shaft. When one electromagnet is energized and the other de-energized, this action is translated through actuating members to en-



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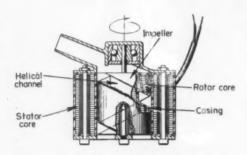
Division of Vocaline Company of America, Inc., Old Saybrook, Conn.

Dept. MD-5

gage one spring element and to disengage the other. Patent 2,975,648 assigned to Curtiss-Wright Corp., by George H. Doerries.

Integrally Powered Pump

The cylinder and impeller in a positive-displacement pump are provided with built-in magnetic cores to produce rotation. A stator core and associated windings are housed within the cylinder unit. In operation, the assembly performs as a single-phase ac motor to drive the rotor core contained within the impeller. Cylinder

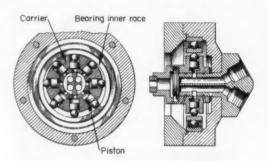


and impeller are encapsulated in electrically nonconductive material to seal the units. A helical channel in the outer periphery of the impeller provides the fluid path for the liquid to be pumped. Patent 2,976,808 as-

signed to Hawkridge Metals Corp., Boston, Mass., by Bert W. Whitehurst

Ball-Actuated Radial Pistons

Radial pistons in a fluid motor are reciprocated by a series of steel balls in rolling contact with an outer bearing to reduce piston wear. The pump carrier enclosing the pistons is eccentric with an outer roller bearing. With rotation, relative angular movement between the two is transmitted to the rolling balls caus-



ing them to oscillate within the cylinder bores. Since forces transmitted by the balls to the pistons are primarily axial and not transverse, piston wear is substantially reduced. This also permits use of shorter pistons (piston length need not exceed piston diameter). Patent 2,972,311 assigned to General Motors Corp., Detroit, Mich., by Everett L. Baugh.

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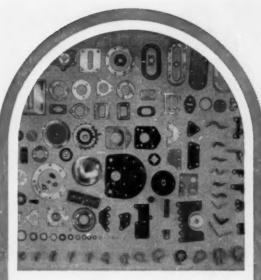
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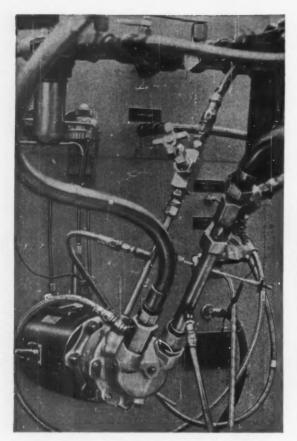
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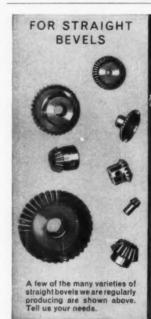
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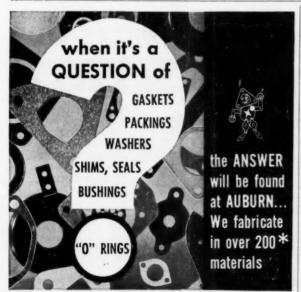




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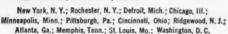


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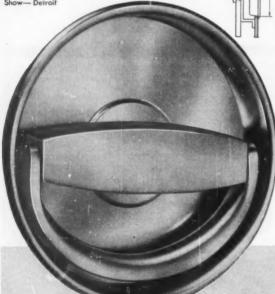
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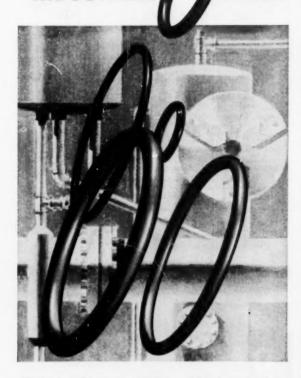


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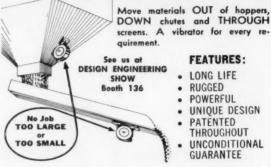
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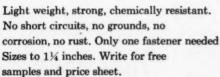
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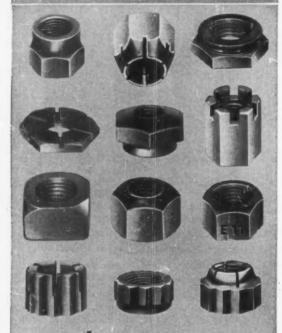


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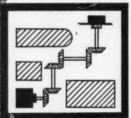
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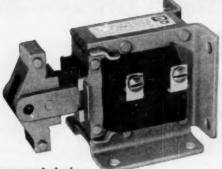


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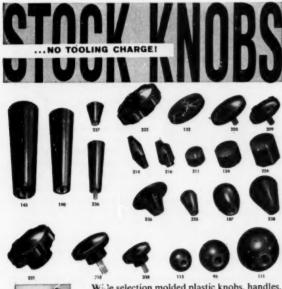
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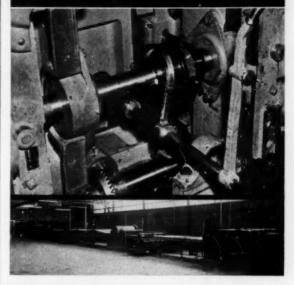


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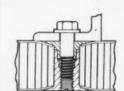
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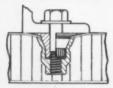
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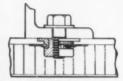


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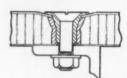




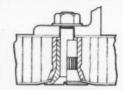
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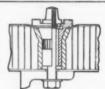
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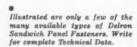
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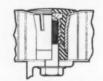


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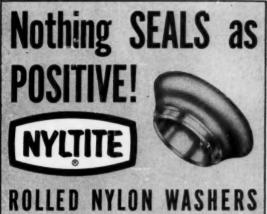
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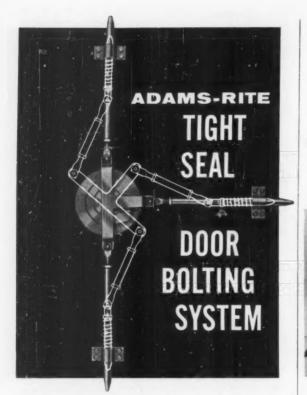


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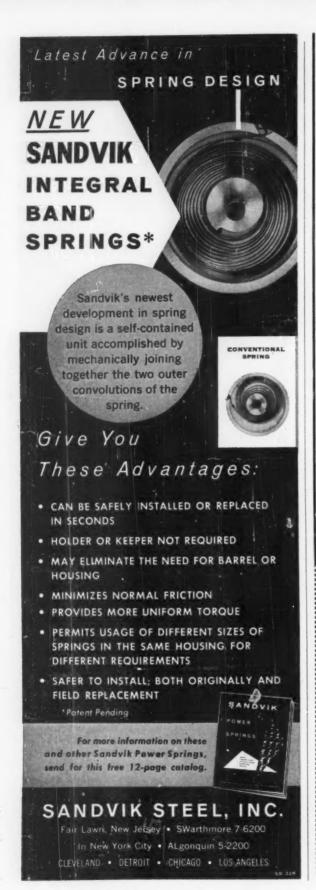
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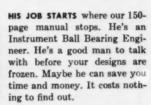
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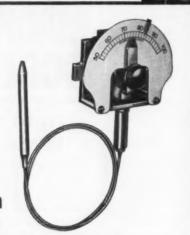
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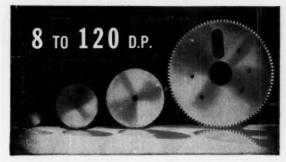
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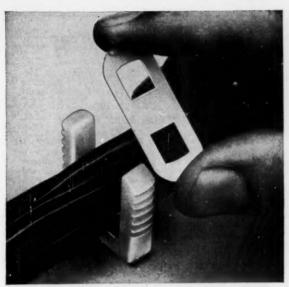
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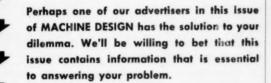
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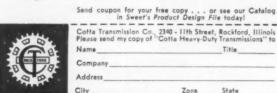
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Advertising Index

Abbott Ball Co., The	294	Cal
Accurate Bushing Co., Smith Bearing Division	344	Car
Acme Chain Corporation	346	Car
Adams Rite Manufacturing Co		Car
Aero Gasket Corporation, The		F
Aetna Ball and Roller Bearing Co., Division		Car
of Parkersburg-Aetna Corporation	271	C.
Airborne Accessories Corporation		Cer
Air Marine Motors, Inc		Cho
Alco Products, Inc		Cho
Alemite Division of Stewart-Warner Corpora-		Che
tion		
Allegheny Ludlum, Carmet Division		Chi
Allenair Corporation		Chi
Allen-Bradley Co127,		Chi
Allen Manufacturing Co		Cin
Allis, Louis, Co., The	, 49	Cir
Aluminum Company of America73		Cla
American Brake Shoe Co., Denison Engineer-		Cla
ing Division American Chain & Cable Co., Inc., Automotive and Aircraft Division	401	Cle
American Chain & Cable Co., Inc., Automo-	309	Cle
American Hardware Corporation, The, Corbin		-
Cabinet Lock Division	404	Col
American Insulator Corporation	377	Col
American Machine & Foundry Co., Potter &		Cor
Brumfield Division	85	Cor
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American Machine & Metals, Inc., The Lamb Electric Co. Division	337	Cor
American Machine & Motals, Inc., United		Cor
States Gauge Division	303	Cor
American Nickeloid Co	1.00	Cor
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American Stock Gear Division, Perfection Gear Co	360	1
American Welding & Manufacturing Co., The	164	Cor
	134	E
AMP, Inc	134	Cor
Armstrong Cork Co., Industrial Division	-	Cor
Ashland Electric Products, Inc.	372	Co
Associated Spring Corporation		1
Atlas Chain & Manufacturing Co		Cor
Auburn Manufacturing Co., The		Cot
Automatic Electric	140	Cra
Automatic Switch Co	18VC	-
Automatic Switch Co Inside Front C Automative and Aircraft Division, American	never 2006	Cra
Automotive and Aircraft Division, American Chain & Cable Co., Inc.	309	Cra
Automotive and Aircraft Division, American Chain & Cable Co., Inc.	309 400	Cra
Automotive and Aircraft Division, American Chain & Cable Co., Inc	309 400 115	Cra Cur
Automotive and Aircraft Division, American Chain & Cable Co., Inc.	309 400 115	Cra Cur
Automotive and Aircraft Division, American Chain & Cable Co., inc	309 400 115	Cra Cur
Automotive and Aircraft Division, American Chain & Cable Co., inc	309 400 115	Cra Cur
Automotive and Aircraft Division, American Chain & Cable Co., inc	309 400 115 289	Cra Cur s Cur
Automotive and Aircraft Division, American Chain & Cable Co., inc	309 400 115 289	Cra Cra Cur Si Cur
Automotive and Aircraft Division, American Chain & Cable Co., inc	309 400 115 289	Cra Cur s Cur Dal
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407	Cra Cur s Cur Dai Dai
Autometive and Aircraft Division, American Chain & Cable Co., inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division.	309 400 115 289 253 407	Cra Cur S Cur Dai Dai
Autometive and Aircraft Division, American Chain & Cable Co., inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division.	309 400 1115 289 253 407 68	Cra Cur s Cur Dai Dai Dar Dar
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Ce	309 400 115 289 253 407 68 52	Cra Cur S Cur Dai Dar Dar Del Del
Autometive and Aircraft Division, American Chain & Cable Co., inc. Avisum Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division of Associated Spring Corporation Armes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation Barmes, Wallace, Division, Associated Spring	309 400 1115 289 253 407 68 52	Cra Cur S Cur Dai Dar Dar Dei Dei Der S
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52	Cra Cur S Cur Dai Dar Dar Del Del Der S
Automotive and Aircraft Division, American Chain & Cable Co., inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52	Cra Cur S Cur Dai Dai Dar Del Del Der S Dev Dev
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 52 52 378	Cra Cur S Cur Dal Dar Dar Del Der S Des Der S Des Des Des Des Des Des Des Des Des Des
Automotive and Aircraft Division, American Chain & Cable Co., inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 52 378 398	Cra Cur S Cur Dal Dar Del Del Del Del Dia Dia Dia Dia
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Automotive and Aircraft Division, American Chain & Cable Co., inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division. Barnes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation Barnes, Wallace, Division, Associated Spring Corporation Barnes, Wallace, Steel Division, Associated Spring Corporation Beavier Metals Corporation Beavier Gear Works, Inc. Belows-Valvair, Division of International Basic Economy Corporation	309 400 115 289 253 407 68 52 52 52 378 398 310	Cra Cur S Cur Dal Dar Dar Dar Dar Dar Dar Dar Dar Dar Dar
Automative and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 378 398 310 139 399	Cra Cur S Cur Dal Dar Dar Dar Dar Dar Dar Dar Dar Dar Dar
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Automotive and Aircraft Division, American Chain & Cable Co., inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division. Barnes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation Barnes, Wallace, Division, Associated Spring Corporation Barnes, Wallace, Steel Division, Associated Spring Corporation Beavier Metals Corporation Beavier Metals Corporation Beavier Metals Corporation Beavier Metals Corporation Beavier Precision Products, Inc. Bellows-Valvair, Division of International Basic Economy Corporation Beaton Harbor Engineering Works, Inc. B & F Instruments, Inc. B-G-R Division, Associated Spring Corporation	309 400 115 289 253 407 68 52 52 378 398 310 139 399 399 398 52	Cra Cur S Cur Dal Dal Dal Dal Del Dia Dia Dia Dia Dia Dia Dia Dia Dia Dia
Automative and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 52 378 398 310	Cra Cur S Cur Dal Dar Dar Dal Dar Dia Dia Dia Dia Dia Dia Dia Dia Dia Dia
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Ce	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 398 52 371	Cra Cur S Cur Dal Dal Dar Dal Dal Dal Dal Dal Dal Dal Dal Dal Dal
Automotive and Aircraft Division, American Chain & Cable Co., inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division. Barnes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation Barnes, Wallace, Division, Associated Spring Corporation Barnes, Wallace, Steel Division, Associated Spring Corporation Beavier Manufacturing Co. Beaver Gear Works, Inc. Bellows-Valvair, Division of International Basic Economy Corporation Beaton Harbor Engineering Works, Inc. B & F Instruments, Inc. B & F Instruments, Inc. B-G-R Division, Associated Spring Corporation Borg-Warner Corporation, Pesco Products Division Borg-Warner, Rockford Clutch Division	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 398 52 371 243	Cra Cra Cur S Cur Dal Dar Dar Dal Dar Dia Dia Dia Dia Dia Dia Dia Dia Dia Dia
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 52 378 398 399 399 52 371 243	Cra Cra Cur S Cur Dal Dar Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dar Dal Dal Dal Dal Dal Dal Dal Dal Dal Dal
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 52 378 398 399 399 52 371 243	Cra Cra Cra Cur S Cur Bal Dal Dal Dal Dal Dal Dal Dal Dal Dal D
Automotive and Aircraft Division, American Chain & Cable Co., inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division. Barnes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation Barnes, Wallace, Division, Associated Spring Corporation Barnes, Wallace, Steel Division, Associated Spring Corporation Beavier Metals Corporation Beavier Metals Corporation Beavier Precision Products, Inc. Bellows-Valvair, Division of International Basic Economy Corporation Beaton Harbor Engineering Works, Inc. B & F Instruments, Inc. B-G-R Division, Associated Spring Corporation Borg-Warner Corporation, Pesco Products Division Borg-Warner, Rockford Clutch Division Borg-Warner Corporation, Warner Automotive Division Borg-Warner Corporation, Woester Division.	309 400 115 289 253 407 68 52 52 52 378 398 310 139 398 52 371 243 352 353	Cra Cra Cra Cur S Cur Bal Dal Dal Dal Dal Dal Dal Dal Dal Dal D
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisum Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division. Barnes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation Barnes, Wallace, Division, Associated Spring Corporation Barnes, Wallace, Steel Division, Associated Spring Corporation Bearium Metals Corporation Beavium Metals Corporation Beavium Metals Corporation of International Basic Economy Corporation Beavium Metals Corporation of International Basic Economy Corporation Beavium Metals Corporation Products, Inc. Bellows-Valvair, Division of International Basic Economy Corporation Beaton Harbor Engineering Works, Inc. B-G-R Division, Associated Spring Corporation Borg-Warner Corporation, Pesco Products Division Borg-Warner, Rockford Clutch Division Borg-Warner Corporation, Wamer Automotive Division Bower Roller Bearing Division, Federal-Mogul-Bower Roller Bearing Division, Federal-Mogul-Bower Bearings, Inc.	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 52 371 243 352 353 63	Cra Cra Cra Cur S Cur Bal Dal Dal Dal Dal Dal Dal Dal Dal Dal D
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisum Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division. Barnes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation Barnes, Wallace, Division, Associated Spring Corporation Barnes, Wallace, Steel Division, Associated Spring Corporation Bearium Metals Corporation Beavium Metals Corporation Beavium Metals Corporation of International Basic Economy Corporation Beavium Metals Corporation of International Basic Economy Corporation Beavium Metals Corporation Products, Inc. Bellows-Valvair, Division of International Basic Economy Corporation Beaton Harbor Engineering Works, Inc. B-G-R Division, Associated Spring Corporation Borg-Warner Corporation, Pesco Products Division Borg-Warner, Rockford Clutch Division Borg-Warner Corporation, Wamer Automotive Division Bower Roller Bearing Division, Federal-Mogul-Bower Roller Bearing Division, Federal-Mogul-Bower Bearings, Inc.	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 52 371 243 352 353 63	Cra Cra Cra Cur S Cur Bal Dal Dal Dal Dal Dal Dal Dal Dal Dal D
Automative and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 398 52 371 243 352 353 63 272 399	Cra Cra Cra Cur S Cur Bal Dal Dal Dal Dal Dal Dal Dal Dal Dal D
Automative and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co. Barksdale Valves, Pressure Switch Division. Barnes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation Barnes, Wallace, Division, Associated Spring Corporation Barnes, Wallace, Steel Division, Associated Spring Corporation Beaver Gear Works, Inc. Beover Precision Products, Inc. Bellows-Valvair, Division of International Basic Economy Corporation Basic Economy Corporation Beat Instruments, Inc. B-G-R Division, Associated Spring Corporation Borg-Warner Corporation, Pesco Products Division Borg-Warner Corporation, Womer Automative Division Borg-Warner Corporation, Womer Automative Division Bower Roller Bearing Division, Federal-Mogul-Bower Bearings, Inc. Bridgeport Fabrics, Inc. Bridgeport Fabrics, Inc. Bridgeport Fabrics, Inc. Bridgeport Fabrics, Inc. Briggs Filtration Co., The	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 52 371 243 352 353 63 272 399 296	Dall Darris Dall Director Duris Duri
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 52 371 243 352 353 63 272 399 296	Crac Cur S C
Automotive and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 398 52 371 243 352 353 63 272 399 296 16	Crac Cur S C
Automative and Aircraft Division, American Chain & Cable Co., inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Ce	309 400 115 289 253 407 68 52 52 52 378 398 310 139 399 398 52 371 243 352 353 63 272 399 16 16 399	Crac Curr S Curr
Automative and Aircraft Division, American Chain & Cable Co., Inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Co	309 400 115 289 253 407 68 52 52 378 398 391 310 139 399 398 52 371 243 353 63 272 399 296 16 395 420	Crac Cur S C
Automative and Aircraft Division, American Chain & Cable Co., inc. Auto-Ponents, Inc. Avisun Corporation Avondale Shipyards, Inc., Service Foundry Division Barber-Colman Ce	309 400 115 289 253 407 68 52 52 378 398 391 310 139 399 398 52 371 243 353 63 272 399 296 16 395 420	Cra Cur si Cur

Calumet & Hecla, Inc., Flexonics Division	
	353
Cambridge Wire Cloth Co., The	124
Carpenter Steel Co., The	81
Carr Fastener Co., Division of United-Carr Fastener Corporation	259
Fastener Corporation	314
Carter Controls, Inc.	399
C. E. M. Co., Inc.	313
Champion Rivet Co., The	
Chamical Materials Deet General Blackis	301
Chemical Materials Dept., General Electric	105
Chicago-Allis Mfg. Corporation	263
Chicago Lock Co	389
Chrysler Corporation, Amplex Division	403
Cincinnati Gear Co., The	80
Circle F Mfg. Co	376
Clare, C. P., & Co	121
Clark Controller Co., The	297
Clearprint Paper Co	69
Cleveland Worm & Gear Division, Eaton Manufacturing Co.	
Manufacturing Co	155
Cole-Hersee Co	418
Colorado Oil & Gas Corporation, Marsh In- strument Co. Division	262
Combination Pump Valve Co	-
Cone-Drive Gears, Division of Michigan Tool	
Co	375
Consolidated Molded Products Corporation	339
Continental Felt Co	412
Continental Rubber Works	368
Continental Screw Co	95
Controls Company of America, Appliance and	
Automotive Division	409
Controls Company of America, Control Switch Division	39
Control Switch Division, Controls Company of America	39
Con-Vel Division, Dana Corporation	35
Corbin Cabinet Lock Division, The American	
Hardware Corporation	404
Corrosion Reaction Consultants	269
Cotta Transmission Co	420
Cramer Controls Corporation, Electromechani-	
cal Division	425 287
cal Division	425
cal Division	425 287 335
cal Division Crane Pucking Co. Crawford Fitting Co. Cuttiss-Wright Corporation, Marquette Division	425 287 335
cal Division	425 287 335
cal Division Crane Pucking Co. Crawford Fitting Co. Cuttiss-Wright Corporation, Marquette Division	425 287 335
cal Division Crane Pucking Co. Crawford Fitting Co. Cuttiss-Wright Corporation, Marquette Division	425 287 335
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marquette Division Curtis Universal Joint Co., Inc.	425 287 335 104 280
cal Division Crane Pucking Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marquette Division Curtis Universal Joint Co., Inc.	425 287 335 104 280
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marquette Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc.	425 287 335 104 280 342 419
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marquette Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Daha Corporation, Con-Vel Division	425 287 335 104 280 342 419 35
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The	425 287 335 104 280 342 419 35 254
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marquette Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delovan Manufacturing Co.	425 287 335 104 280 342 419 35 254 295
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marquette Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Daha Corporation, Con-Vel Division Danielson Manufacturing Co., The Delena Co., Inc., Inc. Delena Co., Inc., Inc.	425 287 335 104 280 342 419 35 254
cal Division Crane Packing Co. Crawford Fitting Co. Curtis-Wright Corporation, Marquette Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co. The Delavan Co., Inc., The Delavan Denison Engineering Division, American Brake	425 287 335 104 280 342 419 35 254 295
cal Division Crane Packing Co. Crawford Fitting Co. Curtis-Wright Corporation, Marquette Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co. The Delavan Co., Inc., The Delavan Denison Engineering Division, American Brake	425 287 335 184 280 342 419 35 254 295 410 401 401
cal Division Crane Packing Co. Crawford Fitting Co. Curtis-Wright Corporation, Marquette Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delron Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Daublin Co.	425 287 335 104 280 342 419 35 254 295 410 401 410 411
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marquette Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delron Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Daublin Co. Dialight Corporation Diamond Chain Co., Inc.	425 287 335 104 280 342 419 35 254 295 410 401 411 283
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marquette Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Daha Corporation, Con-Vel Division Danielson Manufacturing Co. The Delavan Manufacturing Co., The Delavan Manufacturing Co., Inc. Delavan Manufacturing Co., Inc., Delavan Manufacturing Co. Delavan Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc.	425 287 335 104 280 342 419 35 254 295 410 401 411 283 405
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marqueria Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delayan Manufacturing Co. The Delayan Manufacturing Co. Delion Co., Inc., The Delayan Manufacturing Co. Dialight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc.	425 287 335 104 280 342 419 35 254 295 410 411 283 405 409
cal Division Crane Packing Co. Crawford Fitting Co. Curtis-Wright Corporation, Marquette Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delron Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Daublin Co. Dialight Corporation Dialmend Chain Co., Inc. Dillon, W. C., & Co., Inc. Dimco-Gray Co. Dodge Manufacturing Corporation	425 287 335 104 280 342 419 35 254 295 410 401 411 283 405 409 100
cal Division Crane Packing Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delay Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dimac-Gray Co. Didge Manufacturing Corporation Doerr Electric Corporation	425 287 335 104 280 342 419 35 254 295 410 401 411 283 405 409 100 404
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delavan Manufacturing Co. Dialison Manufacturing Co. Dialison Manufacturing Co. Dialison Manufacturing Co. Dialisht Corporation Diamond Chain Co., Inc. Dillion, W. C., & Co., Inc. Dillion, W. C., & Co., Inc. Dimco-Gray Co. Dodge Manufacturing Corporation Doerr Electric Corporation Driv-Lok Sales Corporation	425 287 335 104 280 342 419 35 254 295 410 411 283 405 409 100 404 397
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delron Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dimzo-Gray Co. Dodge Manufacturing Corporation Doerr Electric Corporation Driv-Lok Sales Corporation Driv-Lok Sales Corporation Drop Forging Association	425 287 335 104 280 342 419 35 254 295 410 411 401 411 283 405 409 100 404 397 343
cal Division Crane Packing Co. Crawford Fitting Co. Curius-Wright Corporation, Marquette Division Curits Universal J.Int Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delion Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Daublin Co. Dialight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dimco-Gray Co. Dodge Manufacturing Corporation Doerr Electric Corporation Doerr Electric Corporation Driv-Lok Sales Corporation Drop Forging Association Drif-Notion Co.	425 287 335 104 280 342 419 35 254 295 410 401 401 401 403 405 409 100 404 397 343 282
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Deliron Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dilmaco-Gray Co. Dodge Manufacturing Corporation Doerr Electric Corporation Driv-Lok Sales Corporation Driv-Lok Sales Corporation Drop Forging Association Duff-Norton Co.	425 287 335 104 280 342 419 35 254 295 410 401 401 401 403 405 409 100 404 397 343 282
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marqueria Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delron Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dimco-Gray Co. Dodge Manufacturing Corporation Doerr Electric Corporation Driv-Lok Sales Corporation Driv-Lok Sales Corporation Duff-Norton Co. Dumont Engineering Dunbar Brothers Division, Associated Spring	425 287 335 104 280 342 419 35 254 295 410 401 401 401 403 405 409 100 404 397 343 282
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Deliron Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dirvi-Lok Sales Corporation Doer Electric Corporation Driv-Lok Sales Corporation Driv-Norton Co. Dumont Engineering Dumont Engineering Dumont Engineering Dumont Brothers Division, Associated Spring Corporation Durgaretallic Corporation	425 287 335 704 280 342 419 35 410 401 410 411 400 404 397 343 282 402
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marquette Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delion Engineering Division, American Brake Shae Co. Delion Co., Inc., The Didlight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dimco-Gray Co. Dodge Manufacturing Corporation Driv-Lok Sales Corporation Driv-Lok Sales Corporation Duff-Norton Co. Dumont Engineering Dunbar Brothers Division, Associated Spring Corporation Durantellic Corporation	425 287 333 104 280 342 419 35 254 295 410 401 401 403 404 397 397 343 282 402 52 358
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delion Co., Inc., The Dilion W. Co., Co., Inc. Dimand Chain Co., Inc. Dillion, W. C., & Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Corporation Diamond Chain Co., Inc. Dimand Co., Inc. Dimand Chain Chai	425 287 335 104 280 342 419 35 254 295 410 411 283 340 405 409 100 404 397 343 282 402 52 358 321
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marquette Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delion Engineering Division, American Brake Shae Co. Delion Co., Inc., The Didlight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dimco-Gray Co. Dodge Manufacturing Corporation Driv-Lok Sales Corporation Driv-Lok Sales Corporation Duff-Norton Co. Dumont Engineering Dunbar Brothers Division, Associated Spring Corporation Durantellic Corporation	425 287 333 104 280 342 419 35 254 295 410 401 401 403 404 397 397 343 282 402 52 358
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delion Co., Inc., The Dilion W. Co., Co., Inc. Dimand Chain Co., Inc. Dillion, W. C., & Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Corporation Diamond Chain Co., Inc. Dimand Co., Inc. Dimand Chain Chai	425 287 335 104 280 342 419 35 254 295 410 411 283 340 405 409 100 404 397 343 282 402 52 358 321
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtiss-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co., The Delion Co., Inc., The Dilion W. Co., Co., Inc. Dimand Chain Co., Inc. Dillion, W. C., & Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Chain Co., Inc. Dimand Corporation Diamond Chain Co., Inc. Dimand Co., Inc. Dimand Chain Chai	425 287 335 104 280 342 419 35 254 295 410 411 283 340 405 409 100 404 397 343 282 402 52 358 321
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marqueria Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delavan Manufacturing Co. Dialison Manufacturing Co. Dinc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dillion, W. C., & Co., Inc. Dillion, W. C., & Co., Inc. Dimco-Gray Co. Dodge Manufacturing Corporation Doerr Electric Corporation Drop Forging Association Duff-Norton Co. Dumont Engineering Dunbar Brothers Division, Associated Spring Corporation Durametallic Corporation Durametallic Corporation Durametallic Corporation Durametallic Corporation Durametallic Corporation Durametallic Corporation	425 287 335 104 280 342 419 35 254 295 410 411 283 340 405 409 100 404 397 343 282 402 52 358 321
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marqueria Division Curtis Universal Joint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Con-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Deliron Co., Inc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dillon, W. C., & Co., Inc. Dirvi-Lok Sales Corporation Drivi-Lok Sales Corporation Drivi-Porton Co. Dumont Engineering Dumont Engineering Dumont Engineering Dumont Engineering Dumont Engineering Dumont Engineering Durametallic Corporation	425 287 335 104 280 342 419 35 254 295 410 411 283 340 405 409 100 404 397 343 282 402 52 358 321
cal Division Crane Packing Co. Crawford Fitting Co. Crawford Fitting Co. Curtis-Wright Corporation, Marqueria Division Curtis Universal Juint Co., Inc. Dahl, G. W., Co., Inc. Dakota Engineering, Inc. Dana Corporation, Cen-Vel Division Danielson Manufacturing Co., The Delavan Manufacturing Co., The Delavan Manufacturing Co. Delavan Manufacturing Co. Dialison Manufacturing Co. Dinc., The Denison Engineering Division, American Brake Shoe Co. Dialight Corporation Diamond Chain Co., Inc. Dillion, W. C., & Co., Inc. Dillion, W. C., & Co., Inc. Dimco-Gray Co. Dodge Manufacturing Corporation Doerr Electric Corporation Drop Forging Association Duff-Norton Co. Dumont Engineering Dunbar Brothers Division, Associated Spring Corporation Durametallic Corporation Durametallic Corporation Durametallic Corporation Durametallic Corporation Durametallic Corporation Durametallic Corporation	425 287 335 104 280 342 419 35 254 295 410 401 410 401 403 404 404 397 343 282 402 52 358 321 47

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Advertising Index

Eaten Manufacturing Co., Reliance Division. Elastic Step Net Corporation of America. Electro Devices, Inc., Servespeed Division Elliott Co	351 350 , 87 260	Howe Sound Co., Quaker State Metals Co. Division Hydraulic Unit Specialties Co. Hydreco Division, The New York Air Brake Co. Imperial-Eastman Corporation	385 408 141	Michigan Tool Co., Cone-Drive Gears Division Midland-Ross Corporation, Waldron-Hartig Di- vision Midvale-Heppenstall Co. Miller Fluid Power, Division of Flick-Reedy Corporation Milwaukee Division, Associated Spring Cor- poration Minnesota, Mining and Manufacturing Co. 400,	316 5 101 52 401
Exact Weight Scale Co., The		Indium Corporation of America, The Industrial Tectonics, Inc., Ball Division Ladustrial Timer Corporation, Line Electric Co. Division	390 325 347	Minnesoto, Mining and Manufacturing Co., Adhesives, Coctings and Sealers Division Minnesota Rubber Co. Mobay Chemical Co	135 71 415 402
Stratos Corporation	254 143 133	International Business Machines Corporation International Packings Corporation	423	Motordyne, Inc. Motordyne, Inc. Motoresearch Co. Meuller Brass Co. 117,	251 400
Federal-Mogul-Bower Bearings, Inc., Bower Roller Bearing Division	63 322	Jerphak Bayless	420		
Fenwal, Inc. Ferguson Machine Co. Flexible Tubing Corporation Flexonics, Division of Calumet & Hecla, Inc	366 75 363	Johns-Manville Johnson, Carlyle, Machine Co., The Jones & Laughlin Steel Corporation, Stainless and Strip Division	317 338	National Machine Products Co	
Flick-Reedy Corporation, Miller Fluid Power Division	101 397	Joy Manufacturing Ce.		National Vulcanized Fibre Co. New York Air Brake Co., The, Hydreco Division New Hampshire Ball Bearings, Inc.	
Franklin Electric Co., Inc.	89	Kaydon Engineering Corporation, The Kennametal, Inc. Keuffel & Esser Co. Keystone Steel & Wire Co.	328 119	New Jersey Zinc Co., The Nice Ball Bearing Co. Nopak Division, Galland-Henning Norgren, C. A., Co. Nylok Corporation, The	160 329 11 156
Galland-Henning, Nopak Division		Lamb Electric Co., The, Division of American		Nyltite Corporation of America	411
Garlock, Inc93,		Machine and Metals, Inc.	337		
Gast Manufacturing Corporation		Laminated Shim Co., Inc., The		Ohio Division, Associated Spring Corporation	52
Gates Rubber Co., The General Aniline & Film Corporation, Ozalid Division		Law Blower Co., The	396	Ohmite Manufacturing Co	
General Electric Co., Chemical Material Dept. General Industries Co., The	105	Lincoln Engineering Co., Division of The McNeil Machine & Engineering Co		Onan Division, Studebaker-Packard Corpora-	116
General Motors Corporation, Saginaw Steering Gear Division		Line Electric Co., Division of Industrial Timer Corporation		Orange Roller Bearing Co., Inc	
Gerbing Manufacturing Corporation Gibson Division, Associated Spring Corpora-	410	Ling Electronics Division, Ling-Temco Elec- tronics, Inc		vision Ozalid, Division of General Aniline & Film Corporation	
fión		Division256,	257		
Gleason Works	387	Lisle Corporation			
Groov-Pin Corporation		Lockheed/Missiles and Space Division Long-Lok Corporation			
GIOVAII CORPORATION	***	Lord Manufacturing Co	152 88	Parker Fittings and Hose Division, Parker Hannifin Corporation Parker Hannifin Corporation, Hannifin Co. Di-	
		Lyon Metal Products, Inc		vision	272
Hamilton Foundry, Inc		Lyon maid Flowers, inc.	401	Parker Hannifin Corporation, Parker Fittings and Hose Division	136
Hamilton Watch Co., Metals and Electronics Division	374			and Roller Bearing Co. Division	
Handy & Harmon	302	McGill Manufacturing Co., Inc., Bearing Di-		Pathon Manufacturing Co	
Hanna Engineering Works		wision		Peerless Electric Division, H. K. Porter Co., Inc.	
ration Hansen Manufacturing Co., The		Lincoln Engineering Co. Division	331	Penn Engineering & Manufacturing Corpora-	205
Hart Manufacturing Co., The	262			Perfect Circle Corporation, Castings Division 32,	
Hart Reduction Pulley Co				Perfection Gear Co., American Stock Gear Di- wision	260
Haven Industries, Inc., Taunton Division		Mac-It Parts Co		Perfecting Service Co	
Heim Co., The		Malayan Tin Bureau, The		Pesco Products Division, Borg-Warner Corpo-	
Hewitt-Robins		Manhattan Rubber Division, Raybestos-Man-		Pheoll Manufacturing Co., Inc Inside Back Co	
Hilliard Corporation, The		hattan, Inc. Manning, Maxwell & Moore, Inc.		Philadelphia Gear Corporation	
Hitachi, Ltd	426	Manross, F. N., and Sons Division, Associated		Plastics Products Division, Raybestos-Manhat- tan, Inc.	57
Hitchiner Manufacturing Co		Spring Corporation Marquette Division, Curtiss-Wright Corporation		Polymer Corporation of Pennsylvania, The 3	
Hoke, Inc. Holtzer-Cabot Motor Division, National Pneu-	401	Marsh Instrument Co., Division of Colorado		Pope Machinery Corporation	
matic Co., Inc	384	Oil & Gas Corporation		Porter, H. K., Co., Inc., Peerless Electric Division	130
Mocker Chemical Corporation, Durez Plastics Division	321	Mayline Co., Inc.		Porter, H. K., Co., Inc., Riverside-Alloy Metal	
Hoover Ball and Bearing Co	67	M-D Blowers, Inc.		Potter & Brumfield, Division of American Ma-	:49
Horsburgh & Scott Co., The		Mead Specialties Co		chine & Foundry Co	85
			100	Precision Hydraulics Division, Owatonna Tool	

Advertising Index

Precision Tool & Mfg. Co 413	Studebaker-Packard Corporation, Onan Divi-
Precision Tube Co	sion
Protective Closures Co., Inc., Caplugs Division 361	Superior Tube Co
Purolator Products, Inc	Synthane Corporation
1900000 11000000, 11100 1110000000000000	
	· ·
	Taylor Devices, Inc
Quaker State Metals Co., A Division of Howe	Thomson Industries, Inc
Sound Co	Timken Roller Bearing Co., TheBack Cover
Guinn-Berry Corporation	Tinnerman Products, Inc
	Titchener, E. H., and Co
	Torq Engineered Products, Inc
	Torringion Co., The
Racine Hydraulics & Machinery, Inc., Hydrau-	Trent Tube Co
lics Division	Tru-Seal Division, Flick-Reedy Corporation 397
Rae Motor Corporation	Tubular Rivet & Stud Co
Raybestos-Manhattan, Inc56, 57, 260	Twin Disc Clutch Co
Raymond Manufacturing Division, Associated	TWIN DISC CIOICH CO
Spring Corporation	
Reese Metal Products Corporation 296	
Reliance Division, Eaton Manufacturing Co 315	U-U- V-L- L- are
Renbrandt, Inc	Uniform Tubes, Inc
Reuland Electric Co	Union Carbide Corporation, Union Carbide Plastics Co. Division
Rhodes, M. H., Inc 318	Union Carbide Corporation, Silicones Division 77
Riverside-Alloy Metal Division, H. K. Porter Co., Inc	Union Carbide Plastics Co., Division of Union
Robbins & Myers, Inc	Carbide Cerperation
Rockford Clutch, Division of Borg-Warner 243	United-Carr Fastener Corporation, Carr Fas-
Rodney Metals, Inc	tener Co. Division
Rogan Brothers, Inc	United Electric Controls Co
Rohm & Haas	United States Gauge, Division of American Machine & Metals, Inc
Rollway Bearing Co., Inc	
Roper Hydraulics, Inc	United States Graphite Co., The, Division of The Wickes Corporation
	V & E Manufacturing Co 411
Saginaw Steering Gear Division, General Mo-	Veeder-Root, Inc
tors Corporation	Vickers, Inc., Division of Sperry Rand Cor-
Sandusky Foundry & Machine Co 126	poration, Machinery Hydraulics Division50, 51
Sandvik Steel, Inc	Victor Mfg. & Gasket Co
Schrader's, A., Son, Division of Scovill Manufacturing Co., Inc	Viking Pump Co 46
Scott Paper Co	Vimco Mfg. Co., Inc 412
Scovill Manufacturing Co., Inc., A. Schrader's	Vocaline Company of America, Inc., Bristol
Son Division	Motors Division
Scully-Jones and Co., Special Products Divi-	
sion 369	
Seaboard Pacific Division, Associated Spring Corporation 52	
	Wagner Electric Corporation 60
Sealmaster Bearing Division, Stephens-Adam-	Wagner Electric Corporation
son Mfg. Co	Waldes Kohinoor, Inc
son Mfg. Co	Waldes Kohinoor, Inc
son Mfg. Co	Waldron-Harrig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The
Service Foundry, A Division of Avondale Ship- yards, Inc	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44
son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Corporation 419	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Cor-
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Service Foundry, A Division of Avondale Ship- yards, Inc	Waldes Kohinoor, Inc
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son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Corporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40
son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Corporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Cast- ing Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible	Waldes Kohinoer, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379
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son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Corporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division. 145
son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Corporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Cast- ing Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulits Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulits Division 145 Weckesser Co. 407
son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Cerporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Cast- ing Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division. 145
son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Cerporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division 145 Wackesser Co. 407 Western Gear Corporation, Industrial Prod-
son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Cerporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 Simmons Fasteners 126 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157
son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Cerporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Cast- ing Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Woterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States
son Mfg. Co. 284 Service Foundry, A Division of Avondale Ship- yards, Inc. 289 Servometer Cerporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 Simmons Fasteners 114 Simmons Fasteners 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Divi-	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division 145 Wackesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Corporation 419 Servometer Corporation 526 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 50, 51	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division 145 Wackasser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Cerporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 50, 51 Square D Co. 111	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division. 145 Wackesser Co. 407 Western Gear Corporation, Industrial Products Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Corporation 419 Servometer Corporation 526 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 50, 51	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 379 Waukesha Foundry Co. 379 Waukesha Foundry Co. 379 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Cerporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaudilag Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 50, 51 Square D Co. 111 Stackpole Carbon Co., Electronic Components Division 357 Staedler, J. S., Inc. 359	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 334 Webster Electric, Oil Hydraulics Division. 145 Wackesser Co. 407 Western Gear Corporation, Industrial Products Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Corporation 419 Servometer Corporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 30, 51 Square D Co. 111 Stockpole Carbon Co., Electronic Components Division 359 Standard Pressed Steel Co., Industrial Fas-	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 379 Waukesha Foundry Co. 379 Waukesha Foundry Co. 379 Waukesha Foundry Co. 379 Waterman Gar Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winzeler Manufacturing & Tool Co. 417 Wittek Manufacturing & Tool Co. 312
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Cerporation 419 Servometer Cerporation 527 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division 50, 51 Square D Co. 111 Stackpole Cerbon Co., Electronic Components Division 357 Staadler, J. S., Inc. 359 Standard Pressed Steel Co., Industrial Fastener Division 66, 293	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 374 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winzeler Manufacturing & Tool Co. 112 Wood's, T. B., Sons Co. 326
Son Mfg. Co	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F., Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 379 Waukesha Foundry Co. 379 Waukesha Foundry Co. 379 Waukesha Foundry Co. 379 Waterman Gar Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winzeler Manufacturing & Tool Co. 417 Wittek Manufacturing & Tool Co. 312
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Corporation 419 Servometer Corporation 419 Servometer Corporation 526 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc. Division, Machinery Hydraulics Division. 30, 51 Square D Co. 111 Stockpole Carbon Co., Electronic Components Division 357 Standard Pressed Steel Co., Industrial Fastener Division 66, 293 Star Stainless Screw Co. 415 Steams Electric Corporation 264, 265	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 374 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winzeler Manufacturing & Tool Co. 112 Wood's, T. B., Sons Co. 326
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Cerporation 419 Servometer Cerporation 520 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Fumace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 50, 51 Square D Co. 111 Stackpole Cerbon Co., Electronic Components Division 357 Staadler, J. S., Inc. 359 Standard Pressed Steel Co., Industrial Fastener Division 66, 293 Star Stainless Screw Co. 415 Steams Electric Corporation 264, 265 Steams Electric Corporation 264, 265 Steams Electric Corporation 264, 265	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 374 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winzeler Manufacturing & Tool Co. 112 Wood's, T. B., Sons Co. 326
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Cerporation 419 Servometer Cerporation 520 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spauding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 30, 51 Square D Co. 111 Stackpole Carbon Co., Electronic Components Division 357 Staadler, J. S., Inc. 359 Standard Pressed Steel Co., Industrial Fastener Division 66, 293 Star Stainless Screw Co. 415 Steephens-Adamson Mfg. Co., Sealmaster Bearing Division Mfg. Co., Sealmaster Bearing Division 4294	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 374 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winzeler Manufacturing & Tool Co. 112 Wood's, T. B., Sons Co. 326
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Corporation 419 Servometer Corporation 419 Servometer Corporation 526 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Sier-Bath Gear & Pump Co., Inc. 76 Sier-Bath Gear & Pump Co., Inc. 76 Sigma Instruments, Inc. 349 Sigma Instruments, Inc. 267 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc. Division, Machinery Hydraulics Division. 50, 51 Square D Co. 111 Steckpole Carbon Co., Electronic Components Division 357 Staadler, J. S., Inc. 359 Standard Pressed Steel Co., Industrial Fostener Division 66, 293 Star Stainless Screw Co. 415 Steams Electric Corporation 264, 265 Stephens-Adamson Mfg. Co., Sealmaster Bearing Division Mfg. Co., 201 Sterling Electric Motors, Inc. 102, 103	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warmer Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 374 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winzeler Manufacturing & Tool Co. 112 Wood's, T. B., Sons Co. 326
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Corporation 419 Servometer Corporation 520 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 50, 51 Square D Co. 111 Stackpole Carbon Co., Electronic Components Division 357 Standard Pressed Steel Co., Industrial Fastener Division 66, 293 Star Stainless Screw Co. 415 Steams Electric Corporation 264, 265 Stephens-Adamson Mfg. Co., Sealmaster Bearing Division 284 Sterling Electric Corporation, 264, 265 Stephens-Adamson Mfg. Co., Sealmaster Bearing Division 284 Sterling Electric Corporation, 264, 265 Stephens-Adamson Mfg. Co., Sealmaster Bearing Division 299	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 374 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winsmith, Inc. 312 Wood's, T. B., Sons Co. 326 Wooster Division, Borg-Warner Corporation 353
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Cerporation 419 Servospeed, Division of Electro Devices, Inc. 350 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 50, 51 Square D Co. 111 Stockpole Carbon Co., Electronic Components Division 55 Stadder, J. S., Inc. 359 Standard Pressed Steel Co., Industrial Fastener Division 66, 293 Star Stainless Screw Co. 415 Stepens-Adamson Mfg. Co., Sealmaster Bearing Division Methors, Inc. 102, 103 Stewart-Warner Corporation, 284 Stewart-Warner Corporation, 299 Stillman Rubber Co. 405	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 374 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winsmith, Inc. 312 Wood's, T. B., Sons Co. 326 Wooster Division, Borg-Warner Corporation 353
son Mfg. Co. 284 Service Foundry, A Division of Avondale Shipyards, Inc. 289 Servometer Corporation 419 Servometer Corporation 520 Servo-Tek Products Co. 276 Set Screw & Mfg. Co. 76 Set Screw & Mfg. Co. 76 Shenango Furnace Co., The, Centrifugal Casting Division 131 Sier-Bath Gear & Pump Co., Inc. 45 Sier-Bath Gear & Pump Co., Inc., Flexible Coupling Division 409 Sigma Instruments, Inc. 349 Simmons Fasteners 114 SKF Industries, Inc. 267 Smith Bearing Division, Accurate Bushing Co. 344 Southwest Products Co. 78 Spaulding Fibre Co., Inc. 301 Sperry Rand Corporation, Vickers, Inc., Division, Machinery Hydraulics Division. 50, 51 Square D Co. 111 Stackpole Carbon Co., Electronic Components Division 357 Standard Pressed Steel Co., Industrial Fastener Division 66, 293 Star Stainless Screw Co. 415 Steams Electric Corporation 264, 265 Stephens-Adamson Mfg. Co., Sealmaster Bearing Division 284 Sterling Electric Corporation, 264, 265 Stephens-Adamson Mfg. Co., Sealmaster Bearing Division 284 Sterling Electric Corporation, 264, 265 Stephens-Adamson Mfg. Co., Sealmaster Bearing Division 299	Waldes Kohinoor, Inc. 255 Waldron-Hartig Division, Midland-Ross Corporation 316 Wallingford Steel Co., The 367 Ward Leonard Electric Co. 44 Warner Automotive Division, Borg-Warner Corporation 352 Warner Electric Brake & Clutch Co. 148 Warrick, Charles F. Co. 415 Waterman Hydraulics Corporation 40 Watlow Electric Manufacturing Co. 379 Waukesha Foundry Co. 374 Webster Electric, Oil Hydraulics Division 145 Weckesser Co. 407 Western Gear Corporation, Industrial Products Division 157 White, S. S., Industrial Division 380 Whitey Research Tool Co. 109 Wickes Corporation, The, The United States Graphite Co. Division 106, 107 Wiegand, Edwin L., Co. 311 Williams-Bowman Rubber Co., The 342 Winsmith, Inc. 286 Winsmith, Inc. 312 Wood's, T. B., Sons Co. 326 Wooster Division, Borg-Warner Corporation 353

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Assignments: Designers at the senior or intermediate level are needed with experience in the design and layout of small, complex, high-speed mechanical and electromechanical devices. Considerable knowledge of production design requirements is desirable.

QUALIFICATIONS

Design Engineers: BSME degree plus experience in the design of small mechanisms.

Designers: Experience should include design and layout work with mechanical components.

Benefits: This is an opportunity to get in on the ground floor in new areas with a company that is a leader in its field. Many education programs offered. Excellent salaries. Company benefits are among the best in industry today. All applicants considered without regard to race, creed, color or national origin.

Please write, outlining your qualifications and background, to:

Mr. J. A. Ronvaux, Dept. 590E2 IBM Corporation Lexington, Ky.

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

backtalk-

-Food, for Thought

The roast beef problem discussed on the Editorial page of this issue really was assigned to a class of engineering students. The professor was our good friend and Machine Design author Warren Wilson, chairman of the department of engineering at Harvey Mudd College, Claremont, Calif. However, he reported to us only on the Supported Judgment man—whose answer, incidentally, was remarkably accurate. The other three modes of attack were dreamed up by the Editor.

-Show Girl

The dictionary defines a show girl as "one of the girls, esp. chorus girls, used chiefly for display." Our girl Jane Smith, not esp. suited for display, is more utilitarian—she put together the Design Show Guide on Page 211 of this issue. With the publication of this Guide, Jane carves another big notch in her pica scale, for this is MACHINE DESIGN'S fifth such guide and her fourth.



Jane first encountered the Machine Design editorial department on a summer job between high school and college (Western Reserve). She returned several years later and has been an assistant editor since April, 1951, which makes her the "longest" assistant editor ever associated with the magazine.

When she's not making magazines, Jane likes to make other things—from brownies to pottery (and often you can't tell the difference). Between Design Shows she keeps herself looking busy around the office by turning out some of the sparkling Engineering News pages.

Oh yes-she also writes Backtalk.

-Things Textbooks Don't Tell

In our search for material that will brighten your day, we unearthed the following group of Finagle's Universal Laws for naive engineers, published in a recent issue of our sister publication, Steel. This particular selection is from a longer list, compiled by the Recommended Practices Committee of the International Society of Philosophical Engineers, with an assist from Steel's John Morgan.

The most vital dimension on any plan or drawing stands the greatest chance of being omitted.

If a test installation functions perfectly, all subsequent production units will malfunction.

Major engineering changes will always be requested after fabrication is nearly completed.

Parts that positively cannot be assembled in improper order will by.

Interchangeable parts won't interchange.

All delivery promises must be multiplied by a factor of 2.0.

Manufacturer's specifications of performance should be multiplied by a factor of 0.5.

Salesmen's claims for performance should be multiplied by a factor of 0.25.

Any device requiring service or adjustment will be least accessible.

If more than one person is responsible for a miscalculation, no one will be at fault.

To this list we add another, the Beatnik Law: The failure factor for any project is equal to the sum of the squares who worked on it.

- Double the Treasure

This year's Zinc Die Casting of the Year will win \$500 for the die caster and another \$500 for his customer. A dual prize is offered because the award's sponsor, the New Jersey Zinc Co., feels that "a successful zinc diecasting is the result of a co-operative effort on the part of the customer's design engineers and the die caster."

All producers and users of zinc diecastings are eligible for the competition; the castings must have been produced after May 1, 1960; and the awards will go to the two individuals who have contributed most to the successful design and production of the winning casting. Entry blanks and complete information are available from the New Jersey Zinc Co., 160 Front St., New York 38, N. Y.







EGAD, METHINKS YON DESIGN ENGINEER HATH GONE STIR-CRAZY! HOW COMETH?

Ah, thereby hangs a tale, sire. He needs a time-delay relay with a range from 15 seconds to 30 minutes — or even longer! — yet one with a repeat accuracy of plus or minus 2 per cent of the overall time range.

Simple.

But there is more. He demandeth a reset time of thirty milliseconds! His specs are stringent beyond belief. His is a military problem —

Simple.

Speak not in haste, milord. 'Tis hush-hush stuff. All one may say is that he might be working on radio, radar, camera control, guided missile, flasher, gun purge-door, fire control.—

Hah, still simple, say I. Obviously the fellow doth need an accurate delay between the closing of a control circuit and the actuation of an independent load switch or two. For Cramer's new TYPE 432 Time Delay Relay, such work is child's play! Know ye not that TYPE 432 hath passed such severe Mil tests as operation at 70,000 feet, vibration at 10G peak acceleration from 10 to 2,000 cps, and 50G 11-millisecond

Great Caesar's ghost!

Of a certainty, the unit is hermetically sealed against dust, humidity, salt spray. It is rugged —

But bulky, no doubt. Ah, me!

Not so, TYPE 432 miniature is lightweight, amazingly compact. And why? Because Cramer doth use newly designed 400 cycle and 60-cycle motors, not to mention all manner of ingenious, miniaturized components.

Yet you say it is rugged?

Ho, ho. With a minimum switch life of 50,000 operations! And yet —

And yet -?

I perceive that this design engineer hath a dual problem, for he also needs a cycle timer to control a repeated sequence of operations in a definite time relationship.

'Tis true. Now doth the problem confound the Cramer people?

Nay, nay. Cramer's new TYPE 553 Miniature Cycle Timer is practically a twin of the TYPE 432 Time Delay Relay, and offers an unsurpassed range of programming periods, from 5 seconds to 30 hours.

Happy day! I fly with these glad tidings to you design engineer —

Better yet, methinks, inform the lad that he should get all the facts straight from the — er — horse's mouth, in a manner of speaking. Have him write for Cramer's data-filled Bulletins: PB-553 and/or PB-432. Therein are all questions answered, all problems solved.

CRAMER TYPE 432 MINIATURE TIME DELAY RELAY

Number of Poles 1 and 2 (standard).

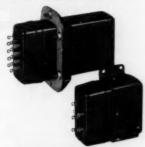
Time Ranges 15 sec to 30 min or longer. Accuracy $\pm 2\%$ of overall time range.

Switches Fast make fast break, SPDT, rated 3 amps resistive and inductive

at 125v ac and 30v dc.

Motor 400 cycle (hysteresis) 115v, 2 watts input; or 60 cycle (permanent magnet) 115v, 2 watts input. DC 26v ±4v using

Mounting Flange or bracket.



CRAMER TYPE 553 MINIATURE CYCLE TIMER

Number of Poles 5.

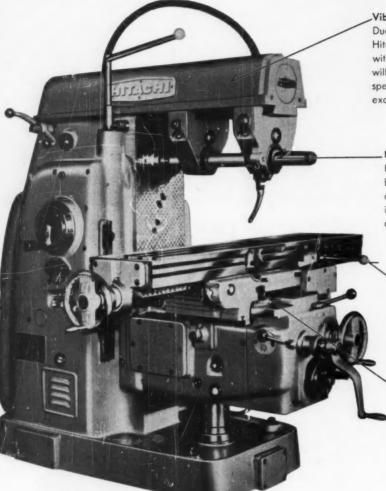
Time Ranges 5 sec (single pole) to 30 hours.

Accuracy ±0.5% of overall time range. Switches, Motor and Mounting Identical to 432.

CRAMER CONTROLS CORPORATION

ELECTROMECHANICAL DIVISION . CENTERBROOK, CONNECTICUT

HITACHI NO. 2 ML MILLING MACHINES



Vibration Damping Device

Due to a vibration damping device of Hitachi's exclusive design contained within the over-arm, minimum vibration will be set up even during higher speeds and feeds operation, so that an excellent finished surface is obtained.

New-Type Arbor Support Bearing Hitachi's unique super precision-type bearing, a combination of plain metal and needle bearing, is incorporated into the machine to enable high speed cutting with high precision results.

Mono-Lever Control System

Hitachi's unique Mono-lever Control System makes the operation simple and easy. Table-feeding too can be performed with ease.

Backlash Eliminator of Lead

As the use of two independent nuts eliminates backlash on the table feed screw, smooth down-cutting can be effected.

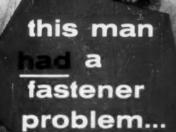
No. 2 ML Plain Milling Machine

SPECIFICATIONS:

- 53 1/8"×10 1/16" Table
- 28" Longitudinal Traverse
- 16 Table Feeds 1/16" 78 3/4"/min.
- 16 Spindle Speeds 25 1,500 r.p.m.
 - 7.5 h.p. Main Motor



Cable Address: "HITACHY" TOKYO



and here's how Pheoll solved it

A recent development by Pheoll has made this fisherman's regular job a lot easier. The job . . . that of electrician.

Specifically, Pheoll has done away with all the red tape—or should we say "black tape"—involved in setting up wiring systems. Now, to make an electrical connection there's no need for tape to tape and tape the wires together. A set of Pheoll designed shouldered brass screws, built into a small plastic case, form handy binding posts around which the wires can be wound and joined. The electrician clamps on the lid, screws it down tight . . . and the connection is made . . . quickly and permanently. No tape deterioration. No shorts.

This is typical of Pheoll experience . . . the application of creative engineering to basic, everyday fastener problems . . . that can be helpful to your company.

Why not call or write Pheoll today?

Pheoll Manufacturing Company, Inc.

5700 WEST ROOSEVELT ROAD

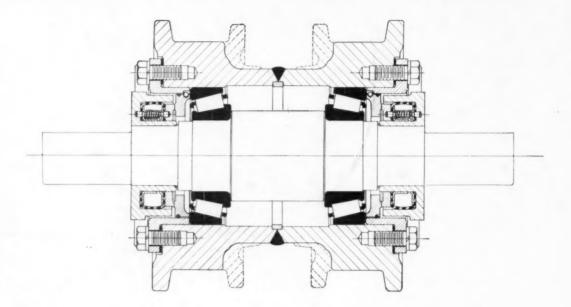
CHICAGO 50, ILLINOIS

Circle 202 on Page 19



HEADING
THE
FASTENER
INDUSTRY
FOR OVER
50 YEARS

How Allis-Chalmers reduces maintenance, boosts work capacity of their crawler tractors



To design both greater work capacity and reduced maintenance into their crawler tractors, Allis-Chalmers engineers used Timken® tapered roller bearings for the heavy duty track rollers.

Timken bearings work with the steel sealing rings to effect a positive seal that makes one-time lubrication possible. Timken bearings keep all parts precisely aligned. They protect the seal by minimizing side thrust and wobble, eliminate wear that makes bushing-type assemblies impossible to seal positively. And the tapered design lets Timken bearings take *both* radial and thrust loads. Full-line contact between rollers and races provides extra load-carrying capacity—extra work capacity.

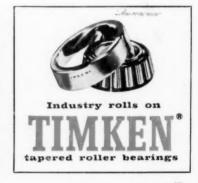
And to deliver more power where it's needed, Timken bearings are also used in the bevel and clutch shaft, final drive pinion, intermediate and sprocket shafts, track idlers and support wheels.



ENGINEERING ASSISTANCE, early in the design stage, helps manufacturers stretch bearing dollars. Timken bearing engineers have the training to do the job and are eager to help you.



METALLURGICAL LAB develops the steels that will make tomorrow's Timken bearings last even longer, help customers to design more economical and durable bearing applications.



The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ont.

